

How to Slash Your
Cellphone Bill

p. 116

THE NATURAL-GAS DEBATE:
IS FRACKING SAFE?

The Light
Bulb Ban

KISS YOUR
100 WATTS
GOODBYE

Popular Mechanics

SCIENCE TECHNOLOGY AUTOMOTIVE HOME ADVENTURE



POPULARMECHANICS.COM SEPTEMBER 2011

AREA 51

WHAT REALLY HAPPENED?

PM
Investigates
An Explosive
New UFO
Conspiracy
Theory






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× SEPTEMBER

THE GUN THAT KILLED BIN LADEN Our editors get some hands-on time with the world's newest celebrity weapon: the Heckler & Koch 416 carbine rifle, which special-operations forces reportedly used to kill terrorist leader Osama bin Laden. The weapon can fire 800 rounds per minute—but Navy SEALs pick their shots with care.

popularmechanics.com/binladen



UNTRUE BLOOD Five synthetic substitutes for blood could bring a steady supply to the battlefield and match the shape and compressibility of real blood cells, for the first time letting lab-created stand-ins squeeze through tight blood vessels.

popularmechanics.com/syntheticblood

ROBOT RECON Army researchers are building teams of autonomous bots that could enter a dangerous building, scan the interior with cameras and lasers and beam a map to soldiers or firefighters waiting outside.

popularmechanics.com/robotrecon

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Housing

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PopMech
Sept.

Boris the robot
has the nose
of a trenching
machine
and exhales
methanol and
propane.



82 What Really Happened in Area 51 A new book about the super-secret military site—a source of UFO and alien conspiracy theories—makes the most shocking claim in Area 51's history. Could a notorious Nazi and a Soviet dictator have conspired to crash a UFO on U.S. soil? The truth is out there. **BY EARL SWIFT**

88 Backyard Genius 2011 There must be something in the water—and homegrown innovators are drinking it up. In our fourth annual salute to outstanding DIY, we celebrate a jet-powered derby car, an automatic beer-brewing machine, an animatronic hand built by a 15-year-old and more. **BY DAVIN COBURN**

96 The Light Bulb Wars A national rollout of new efficiency regulations threatens to cut incandescent bulbs from the home-lighting equation for good, producing a flood of alternatives. But some critics say the ban goes too far—and homeowners will pay the price. PM makes sense of the switch. **BY JOHN HERRMAN**

104 Drilling Down: Fact vs Fiction in the Great Fracking Debate To some, hydraulic fracturing holds the key to vast new supplies of clean natural gas. To others, "fracking" means a slew of complications, including contaminated drinking water. PM cuts through the hype. **BY SEAMUS MCGRAW**

On
the
cover

On a closely guarded parcel in the Nevada desert, Area 51 is a military base where several very impressive aircraft were developed and tested. It has also given rise to several shocking conspiracy theories. **Photo illustration by Anthony Verducci.**

Tech Watch

11 21st-Century Medicine Researchers build an optical-fiber bandage that allows doctors to monitor healing without disturbing the wound. **Plus:** A 2650-mirror solar collector in Spain; engineering killers of drug-resistant bacteria.

Upgrade

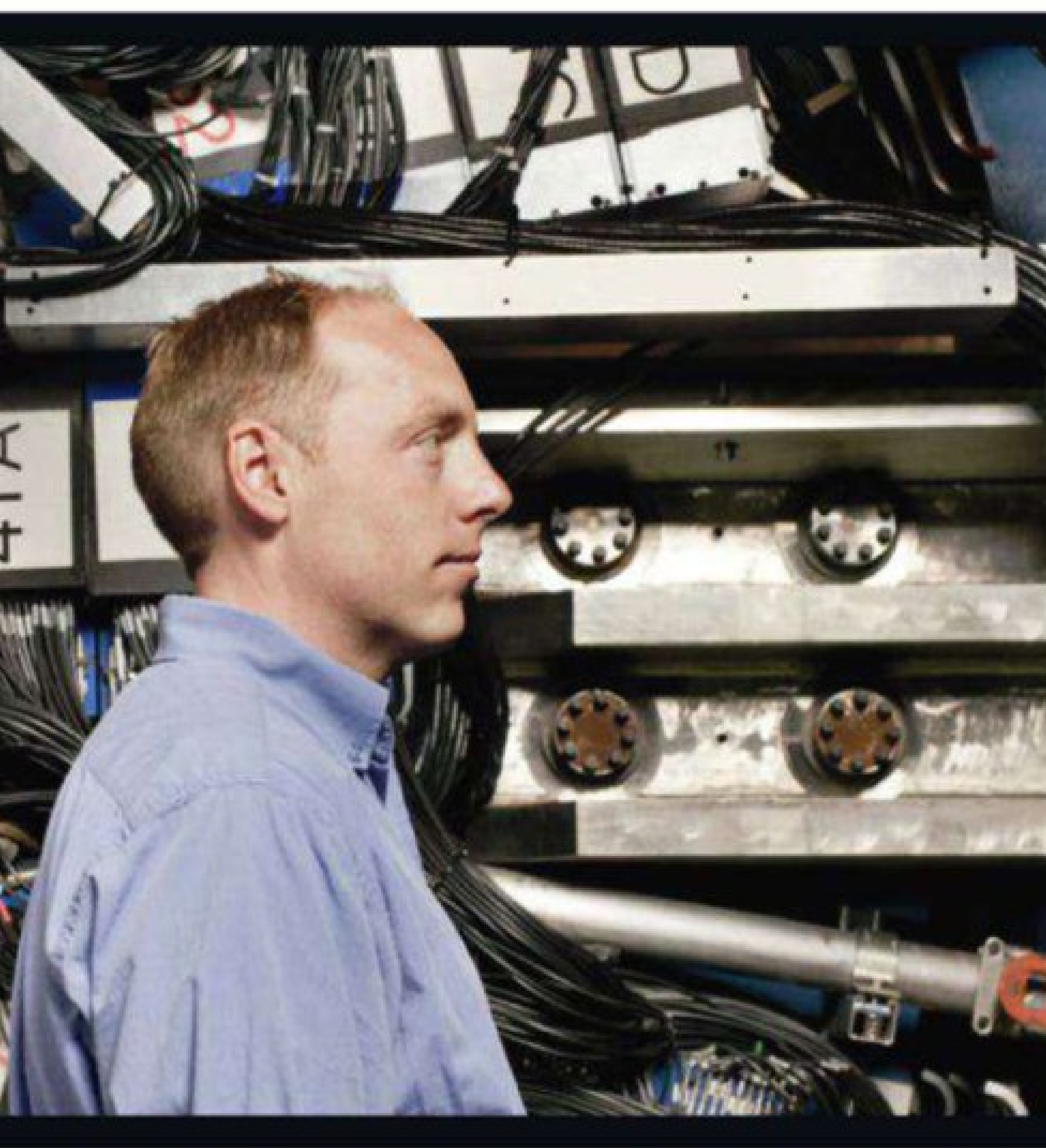
23 Hot Guts Milwaukee's new copper-packed angle grinder cranks out serious torque—and sparks to match. **Plus:** We test breathable rain jackets, review cargo-hauling bicycles and take the measure of new online music-streaming services.

New Cars

39 Sonic Boom Introducing the small, stylish and simple Chevy Sonic. **Plus:** Two ultimate off-roading machines; making sense of the EPA's new window sticker.

52 Long-Term Test Cars The ups and downs of three months with the all-electric Nissan Leaf. **Plus:** Jeep Grand Cherokee Overland and Hyundai Sonata road-test updates.

Nuclear physicist James Dunlop with the STAR detector at Brookhaven National Laboratory in Upton, N.Y.



When you add heat to ice, it melts. Add more heat and it turns to gas. But what happens when you add 4 trillion degrees C? James Dunlop wants to know.
— *This Is My Job*, page 152

Columns

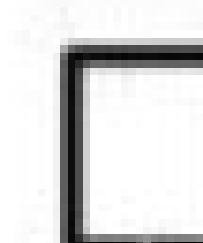
56 Me and My Shadow Jay Leno fills his need for speed and vintage cool with his 1952 Vincent Black Shadow, widely considered to be the world's first superbike.

58 The Real Truth of 9/11 Conspiracy theorists have been spinning tales about Sept. 11 since the attack. PM stands by the truth with a new edition of *Debunking 9/11 Myths*.

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PopMech
diy

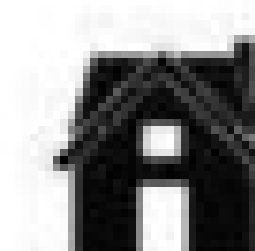


Tech

111 Make Your Own Apps

Have a great idea for a mobile game or digital tool? With simple software, you can design and develop the program yourself.

116 Digital Clinic How much cellphone data do you actually use? **Plus:** The reason for strange computer-screen spots; will your old browser support the new Google?



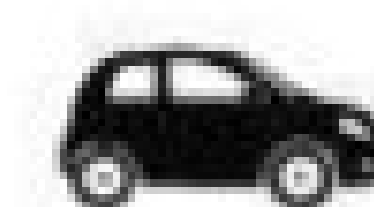
Home

120 Sparks Will Fly With DIY metalworking on the rise, we test six wire-feed welders. Which one is right for you?

126 Homeowners Clinic How to prolong the life of outdoor furniture and other gear.

132 How Your House Works: Backyard Boardwalk New materials and construction techniques multiply the design options of the classic deck.

136 PM Saturday We think you'll agree: Our DIY hammock stand is, well, outstanding.



Auto

139 Saturday Mechanic

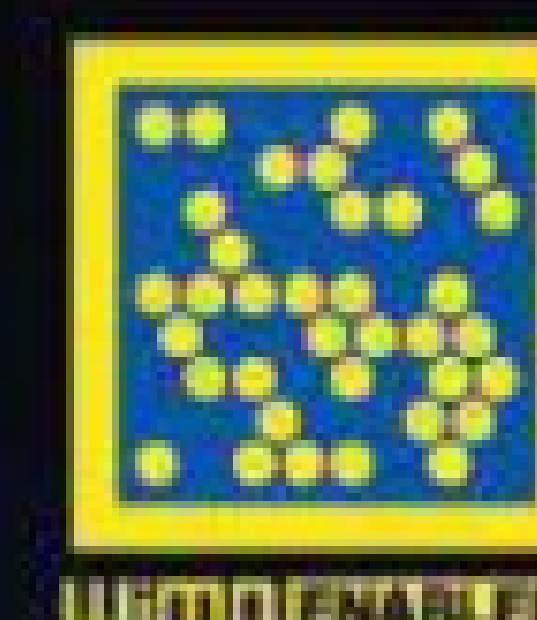
Save \$700 with our DIY oil-pan repair.

142 Car Clinic How to fix LED turn-signal bulbs that flash too fast. **Plus:** Turning off heated mirrors in a 2005 Ford F-350.



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PHOTOGRAPH BY NATHAN PERKEL



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**William
Borucki**SPACE SCIENTIST, NASA
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William Borucki has spent decades devising an elegant way to detect earth-size planets in other solar systems. The culmination of that effort, the Kepler space telescope, launched in 2009, earning his team a Breakthrough Award. This past February, after tallying the data, the mission's lead investigator announced the discovery of more than 1200 likely planets. — ALLIE HAAKE

PM: How did the telescope perform?

WB: The telescope, which simply takes images of the sky every 6 seconds, provides us with a marvelous data set. We found 68 earth-size candidate planets and 54 planets in the habitable zone. Eventually, we'll answer the questions "Are earths common?" and "Are they common in the habitable zone?" If the answers are yes, then they can likely support life, too.

PM: What was your wow moment?

WB: The experience of seeing Kepler launch into space, arc through the sky and disappear into orbit—that was wonderful. The telescope is launched with a cover across the lens. Everybody's sitting in the control room two weeks later, saying, "Let's see if the cover will come off." Sometimes those mechanical things stick, and that's the end of the mission. But it did come off, and we got first light—we saw the stars through it.

For more, visit popularmechanics.com/keplerinterview.

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PM LETTERS

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Standing on an oil rig 300 feet above sea level, Cameron Louis, of Westlake Village, Calif., is on top of the world. The offshore medic maintains fire equipment and runs man-overboard and response drills for the crew. "PM's definitely a favorite," he says. "It teaches me things I can use on the job."

make the list? I count that as one small oversight in an otherwise engrossing story! **BILL WELTE** JOSHUA TREE, CA

Yet Another Way to Save Gas

Thanks for explaining the best tricks and tactics that save gas in DIY Auto "Fighting \$4 Fuel" (July). A variation on your Climb Slowly strategy—which advises drivers to lift off the accelerator while traveling uphill—is to speed up before reaching the hill. You'll probably save fuel and definitely reduce the number of single-finger salutes pointed your way.

JEREMY GUOIN WAUSAU, WI

The Specifics of Mechanics

I loved the definitions in your July DIY Handbook. Here are a few more from the '50s and '60s that my dad used. Dutchman: a sheet-metal tool for cutting arcs and circles. Wood butcher: any

carpenter who was not a cabinetmaker. Mortarboard: another term for a hawk. Hod: the V-shaped container for carrying mud from the cement mixer to the plastering location. Hod carrier: the person who carried the hod from the cement mixer to the plastering location—hard, grueling, unskilled labor. My father used to tell me, "Son, get an education so you don't grow up to be a hod carrier or a ditchdigger." Advice I took to heart. **KEN CRAMER** WILSONVILLE, OR

The Best Gadgets Ever. Period.

Great job on your package rounding up the best gizmos of all time ("101 Gadgets That Changed the World," July). What a list! There is one item I definitely would've liked to see included: the Teletype machine. This important communication device is more than worthy, I'd say. **CHUCK HAMMER** CHARLESTON, SC

You face off Leatherman (No. 47) and Swiss Army Knife (No. 79) and name the latter the winner. While I agree that the knife was ahead of its time, the Leatherman's pliers put it over the top. Plus, it's surely a favorite among deployed troops.

DAN SCHWARTZ GREENVILLE, NC

How in the world is duct tape stuck way back at No. 101?! Behind the Super Soaker? I'm not saying it should be No. 1, but at least give it Top 10 status. If you can't fix it with duct tape, it can't be fixed.

JIM LALLY MONROE, NC

I thoroughly enjoyed your piece on the best gadgets of all time. Still, I couldn't help but wonder: How did Velcro fail to

EDITOR'S NOTE: Glad you liked the handbook. I, too, take my dad's words to heart, but yours steered you wrong in a couple of places. First, I wouldn't advise using the term "wood butcher" on any job site. Somebody might take offense—not a good thing when that somebody is probably wielding a power tool. The fact is, a carpenter is a carpenter—whether he's building a house, ship or what have you. They aren't expected to

be cabinetmakers. Your mortarboard, hawk and hod references also need a little work: Mortar or stucco are mixed in a mortar mixer, on a mortarboard or in a pan, but never in a cement mixer. You carry the material in a bucket or, using a hod, put it onto a board or into a pan. A mason scoops stucco with a trowel and puts it on a hawk. If he's mortaring bricks or blocks, he doesn't use a hawk; he cuts the

mortar off using a brick trowel and applies it to the brick or block. Simply put, a hawk is a hawk, a hod is a hod—and never the twain shall meet. The tools and terms of the mechanical world can make an average person's head spin. But just as a craftsman takes pride in his work, we're picky about our words around here.

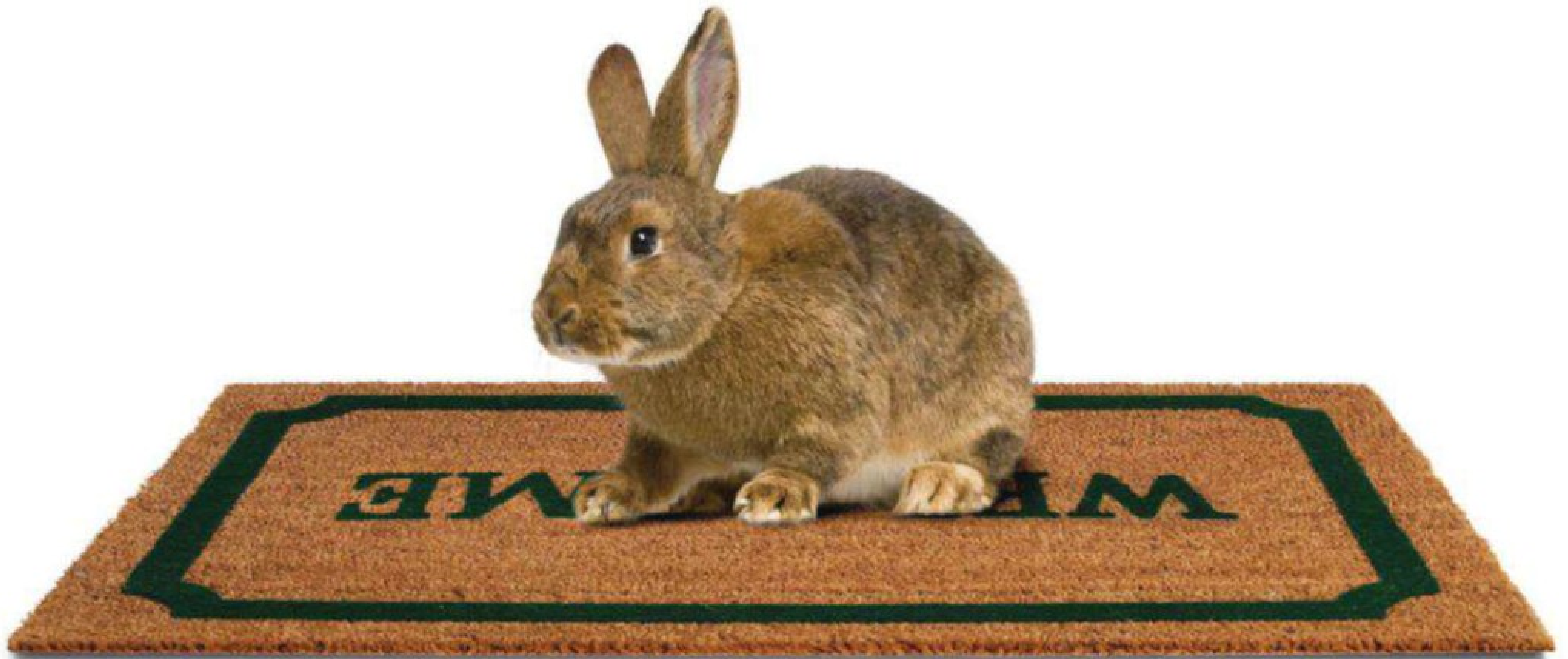
ROY BERENDSOHN
SENIOR HOME EDITOR,
POPULAR MECHANICS

CORRECTIONS: In our "Lessons From Japan" diagram of the pressurized water reactor (July, page 89), "pressurizer" should have read "steam generator." In the same issue, "101 Gadgets That Changed the World" included outdated information about the fire extinguisher (No. 46). Today, most home fire extinguishers contain dry chemicals, not soda acid or carbon tetrachloride.

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do you
think?

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ANTENNA

➔ Tod Sizer, head of wireless research at Bell Labs, has created a 2-inch, low-power cellular antenna that can be mounted on a light post. Instead of radiating signals from the top of tall towers, the small cubes relay multifrequency signals directly to users and offload communications infrastructure from towers to central data centers. "The future is about lower-power solutions serving a smaller number of people," Sizer says.

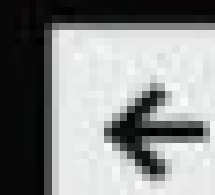
— LOGAN WARD



AIRBUS'S NEW
JET IS . . .
INVISIBLE?

➔ Airbus has unveiled a novel idea for brave airline passengers: a jet with see-through walls. The company introduced a 2050 concept plane with panels on its cabin that are coated with biopolymers that can become transparent, providing panoramic views. The airplane also touts the concept of harvesting energy from the body heat of seated passengers to power the aircraft's lights and holographic entertainment displays. — A.H.

NEWS + TRENDS + BREAKTHROUGHS



TechWatch



21st-Century Medicine · Bright Band-Aids

➔ Repeatedly pulling the dressing off a wound to check on it can slow healing. Researchers in Switzerland have a solution: bandages with **ultrathin, flexible optical fibers** woven into the textile. The fibers have a coating that changes color in response to changes in acidity, which indicate the presence of bacteria or infection. Instead of exposing the wound to take a sample for testing, medical staff would shine light into one end of the fiber and check the color of the light emerging at the opposite end. — ALEX HUTCHINSON

• RECORD BREAKERS

Construction is under way in a remote area of China's Guizhou province on the world's largest radio telescope. When it's completed in 2016, the Five-hundred-meter Aperture Spherical Telescope (FAST) will be three times as sensitive as its nearest competitor and survey the sky 10 times faster. Among the new telescope's goals: Search for extraterrestrial radio signals among 5000 sun-like stars within 100 light-years of Earth. — A.H.

Earth's Largest Radio Telescopes

(IN METERS)



HIP TO B-SQUARE

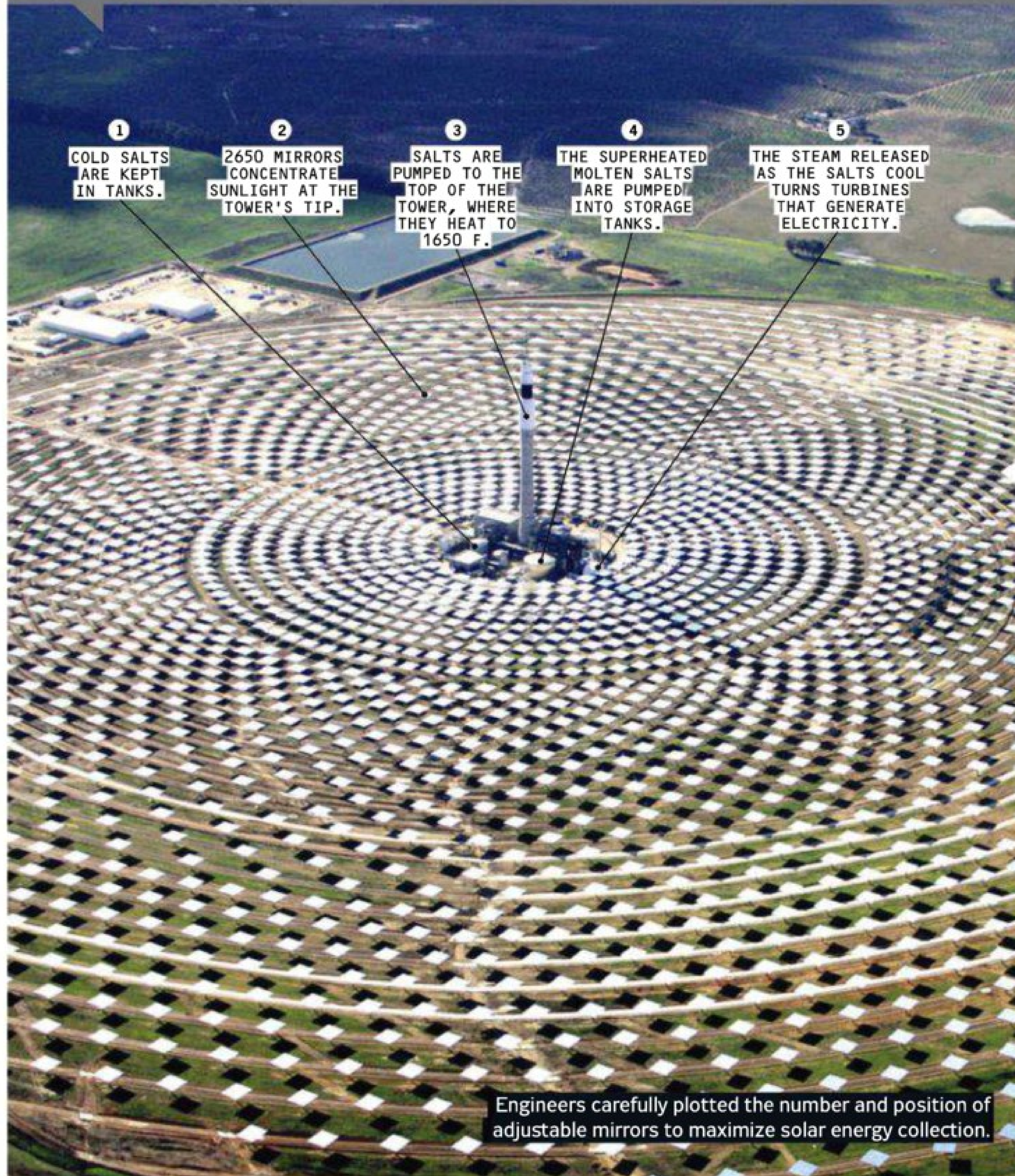
➔ A new kit enables DIYers to easily integrate electronics into their projects—no custom batteries or soldering required. B-Squares, created by 2007 PM Breakthrough Award winner Shawn Frayne and fellow MIT grad Jordan McRae, use magnets at each corner to connect the devices in any direction tinkerers need to stack them. Available B-Squares include a microcomputer, an LED and a solar collector. A single Solar Square costs \$15; it's \$250 for a kit. — AMIR KHAN

TARGETED MARKETING

Brain Scans Predict Hit Songs → In 2006, Emory University researchers in the emerging field of neuroeconomics played 120 obscure songs from Myspace pages to a group of teenagers while monitoring their brain activity with fMRI scanners. Now they've compared that data with sales figures for the songs and found that activity in three key reward areas—the cuneus, orbitofrontal cortex and ventral striatum—partly predicted which songs sold more than 20,000 units between 2007 and 2010. Interestingly, the brain scans predicted future hits far more accurately than the teens' subjective rating of the songs on a scale of 1 to 5.



ALTERNATIVE ENERGY



Engineers carefully plotted the number and position of adjustable mirrors to maximize solar energy collection.



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A UNIQUE SOLAR COLLECTOR BRINGS THE SUN'S POWER TO 25,000 HOMES, DAY OR NIGHT. — ALEX HUTCHINSON

➔ A new solar collector constructed outside Seville, Spain, is redefining the way we harness power from the sun. The newly commissioned 19.9-megawatt Gemasolar plant focuses sunlight from 2650 giant mirrors to the tip of a central tower. The sunlight heats molten salt to 1650 F; this salt is stored, and it produces steam as it cools, powering generators for up to 15 hours at night or during bad weather. Gemasolar is the first commercial-scale concentrating solar plant to use a central tower with thermal storage, a design that promises higher-temperature steam—and thus higher generating efficiency—than competing utility-scale solar designs.



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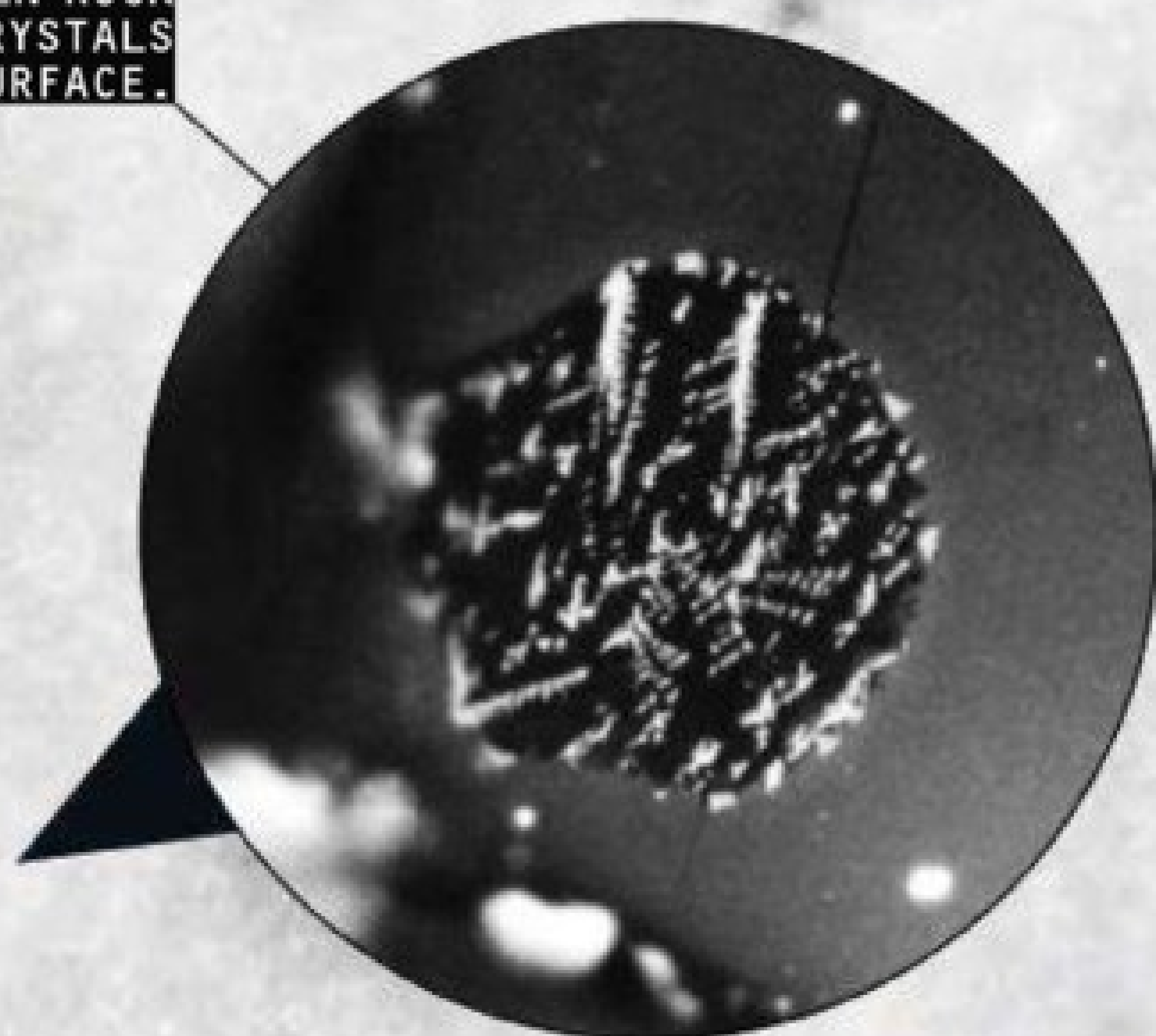
SOLAR SYSTEM MYSTERIES

100x



MORE WATER ON THE MOON THAN PREVIOUSLY BELIEVED

THE EVIDENCE: SCIENTISTS ARE TESTING THE WATER CONTENT OF GLOBULES OF MOLTEN ROCK PRESERVED IN CRYSTALS ON THE MOON'S SURFACE.



Lunar Surprise

Scientists studying samples of lunar rock retrieved during the 1972 Apollo 17 mission have found that the moon's interior may be far wetter than previously believed, according to an article recently published in the journal *Science Express*.

The samples, ejected by lunar volcanic eruptions billions of years ago, are windows into the moon's mantle. The eruptions hurled crystals containing microscopic beads of magma to the surface. The crystals prevent water in the magma from escaping into space, preserving samples of the inaccessible lunar interior.

Scientists have been measuring water content in these rocks for decades, but "the data that came out of those analyses was some combination of laboratory air contamination and solar wind," says Erik Hauri, staff scientist of geochemistry at the Carnegie Institution of Washington and the article's lead author.

Hauri's team used an untried technique, secondary ion mass spectrometry (SIMS), to get more accurate results. The method focuses a 10-micron-thick beam of charged ions onto the globules of magma, removing bits for analysis in a mass spectrometer to determine chemical composition. The results showed a water density of 1400 parts per million.

NASA recently confirmed the presence of ice within permanently shadowed lunar craters, and most scientists believe that comet impacts delivered these troves of water. But the Hauri study supports the idea that at least some of the water is native to the moon. The abundance of water is prompting a reappraisal of a leading lunar formation theory (see left).

— STEVE ROUSSEAU

++

WHERE DOES THE MOON COME FROM? TWO THEORIES HAVE ALREADY COME AND GONE. NOW, JUST WHEN SCIENTISTS WERE IN AGREEMENT ON AN ANSWER, A 2011 STUDY IS CAUSING SOME HEAD SCRATCHING.

THEORY 1:
CONDENSED?

The moon and Earth condensed at the same time from the original nebula that formed the solar system. **CONSENSUS:** Disproved. The moon and Earth do have similar compositions, but the theory does not explain the moon's size and orbit.

THEORY 2:
CAPTURED?

The Earth's gravity ensnared the moon, which was formed elsewhere. **CONSENSUS:** Not likely. A wandering moon, with a composition very similar to Earth's, would have to slow down at just the right time to be captured—an unlikely cosmic coincidence.

THEORY 3:
EJECTED?

A Mars-size body collided with Earth 4.5 billion years ago, and the moon formed from a resultant cloud of magma. **CONSENSUS:** Popular but now in question. If true, the moon would have lost water to heat and into space. However, evidence of elevated water casts doubt on the theory.

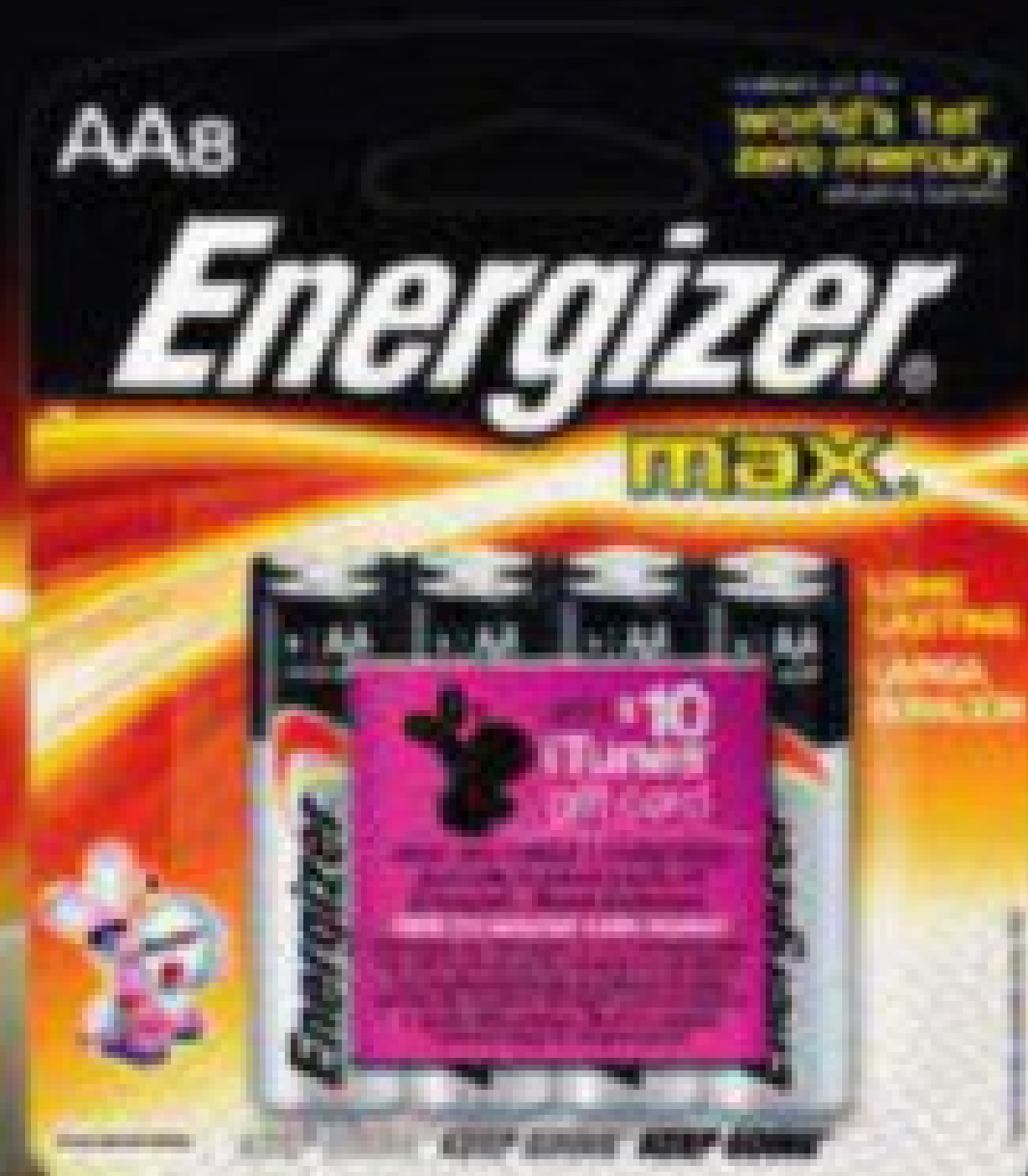


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FOOD SAFETY

Bacteriological Battleground

➔ **This year's *E. coli* outbreak** sickened more than 3900 victims and killed 52 people in Europe and North America. Complicating treatment, the rare strain proved resistant to antibiotics. For seven decades, humanity's primary weapons against harmful bacteria such as certain strains of *Escherichia coli* have been other organisms. For



example, penicillin is naturally produced by a mold that kills bacteria—it introduces a compound that breaks down the harmful microorganism's cell walls. But, because the targeted bacteria have evolved to defend themselves against naturally occurring antibiotics, researchers are crafting new, lethal synthetic remedies to fight drug-resistant bacteria. — LESTER BLACK

European investigators believe sprouts carried a deadly strain of *E. coli*.

TOP BACTERIAL THREATS TO OUR FOOD SUPPLY*

*Centers for Disease
Control and Prevention
2011 estimates

Bacteria

Salmonella

Campylobacter

T. gondii

E. coli O157

Hospitalizations

19,336

8463

4428

2138

NEW WEAPONS OF AN UNSEEN WAR



Proteins

**Lawrence Livermore
National Lab**

➔ Researchers in California have turned *E. coli*'s internal processes against it. Lead researcher Paul Jackson found that a purified form of lytic protein, used by the bacteria to prick small holes in their own cell walls before multiplying, could become a weapon. "Rather than trying to come up with a [new] pathway, we are looking at the pathways that the bacteria already have," Jackson says. These proteins are unique to each species, so the purified form will leave nearby cells unharmed.

Polymers

**Institute of
Bioengineering and
Nanotechnology**

➔ Antibiotics often attack bacteria from inside—but survivors can develop resistance. To break this cycle, researchers from IBN and IBM Almaden Research Center have engineered nanoscale polymers that, like peptides found in the human body, destroy harmful bacteria by damaging cellular walls. "The polymers are emulating our own immune system," Jim Hedrick, study co-director, says. The polymers are biodegradable; once their job is done the human body naturally expels them.

Seeing-Eye Vest

➔ Engineers at the University of Southern California have developed a vest that can guide people with visual impairments. A head-mounted stereo camera feeds 3D data to vision software that identifies obstacles and computes a path around them. The vest contains four micromotors at the shoulders and waist that vibrate like cellphones, alerting users to the location of an obstacle. The next step for the researchers is to shrink the current head-mounted camera system so that it can be mounted on eye-glasses. — ALEX HUTCHINSON



HELMET: MOUNTS
A STEREO CAMERA

VEST: CONTAINS
MICROMOTORS THAT
VIBRATE TO WARN
OF OBSTACLES

BELT: HOLDS
BATTERIES AND
WIRELESS
ROUTER

PHOTOGRAPHS BY GETTY IMAGES

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Speedboat for Science



A PROFESSOR BUILDS A HIGH-SPEED PROTOTYPE THAT COULD CHANGE THE WAY THE U.S. NAVY BUILDS SHIPS. — LARRY WEBSTER

➔ **Ship manufacturers may** one day abandon metal in favor of composite materials, shedding weight to gain fuel efficiency and corrosion resistance. But there are material science lessons that need to be learned before the vessels can take to the water. For answers, researchers at Pennsylvania's Lehigh University, headed by mechanical engineering professor Joachim Grenestedt, designed and

built the 29-foot boat *Numerette* with funding from the Office of Naval Research. It melds a steel frame with foam, fiberglass and carbon-fiber composite panels. "It's difficult to bond different materials," Grenestedt says. "There's a big elastic mismatch that leads to severe stress concentrations at the joints." The 10 panels of the *Numerette's* lower hull are of slightly different construction to determine which best distribute hydrodynamic loads. The *Numerette* is also wired to study "slamming," the impact a boat experiences after cresting a wave. Grenestedt fit each bottom panel with pressure sensors, while other sensors record factors such as temperature and wave height. "Slamming is difficult to study because it's such a dynamic event," he says. "No two impacts are the same." The boat has been tested on a lake at 60 mph, and Grenestedt plans to test its limits on the large swells of the Atlantic.



Numerette

Type: Hybrid-composite-steel speedboat

Materials: The boat's rigid stainless-steel skeleton can support heavy equipment. The composite panels, bonded to the frame with an epoxy adhesive, are lightweight and corrosion-resistant.

Purpose: To study the interaction between the composites and metal in real-world tests, including repeated "slam" impacts against the water's surface.

MODERN WARFARE

Seek & Destroy

READY

A soldier uses the data from a laser rangefinder to manually set the distance at which the round will detonate.

AIM

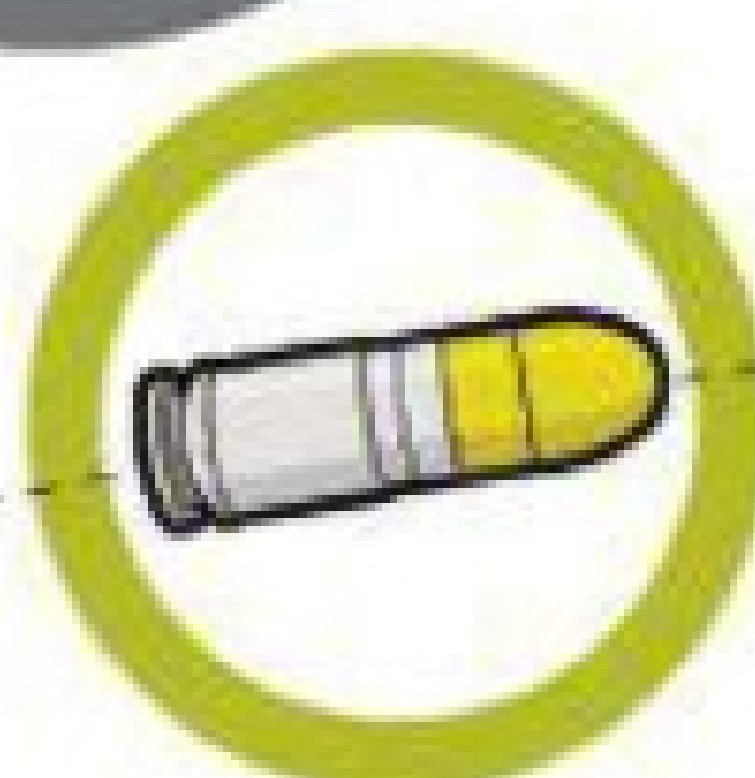
A ballistic computer on the weapon determines the flight profile and sends information to a microchip in the round.

FIRE

A reciprocating barrel reduces recoil. The round measures distance traveled by the number of times it spins.

DETONATE

The round explodes in the air near an otherwise shielded target.



➔ Many high-tech weapons are announced by military scientists and defense firms with great fanfare; then the systems can fade into obscurity once they face the realities of war. But the XM25 Counter Defilade Target Engagement System—a grenade launcher with a ballistic computer that places air-bursting rounds with precision—has been field-tested in Afghanistan, where a limited number of troops determined its readiness for wider deployment. In 2010, the Army delivered five XM25s to soldiers in Afghanistan; they fired 55 rounds in combat and dubbed the weapon "the Punisher." This year XM25 developer ATK received \$65.8 million to finalize the design. Based on soldier feedback, the system will be lighter and have longer battery life than the prototypes and an increased range. It could enter service in 2013. — JOE PAPPALARDO



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COLD PACKS IN YOUR HANDS CAN COOL YOUR WHOLE BODY →



USEFUL DEVICE OR GIMMICK? Texas-based Cool Palms is offering a simple new "core cooling device": a frozen gel pack that athletes strap to their palms.

DARPA-funded studies find that palm-cooling doesn't lower core temperature because the cooling surface area is too small. On the other hand, University of New Mexico researchers found that weight lifters could bench-press 30 percent more wearing palm-coolers between sets, suggesting that just *feeling* cool can boost performance.

HEALTH SCIENCE

Exercise Myths Debunked

PM CONTRIBUTING EDITOR ALEX HUTCHINSON, AUTHOR OF THE NEW BOOK *WHICH COMES FIRST, CARDIO OR WEIGHTS?*, EXPLORES MISCONCEPTIONS AT THE INTERSECTION OF SCIENCE AND FITNESS.



STRETCHING PREPARES YOUR BODY FOR EXERCISE

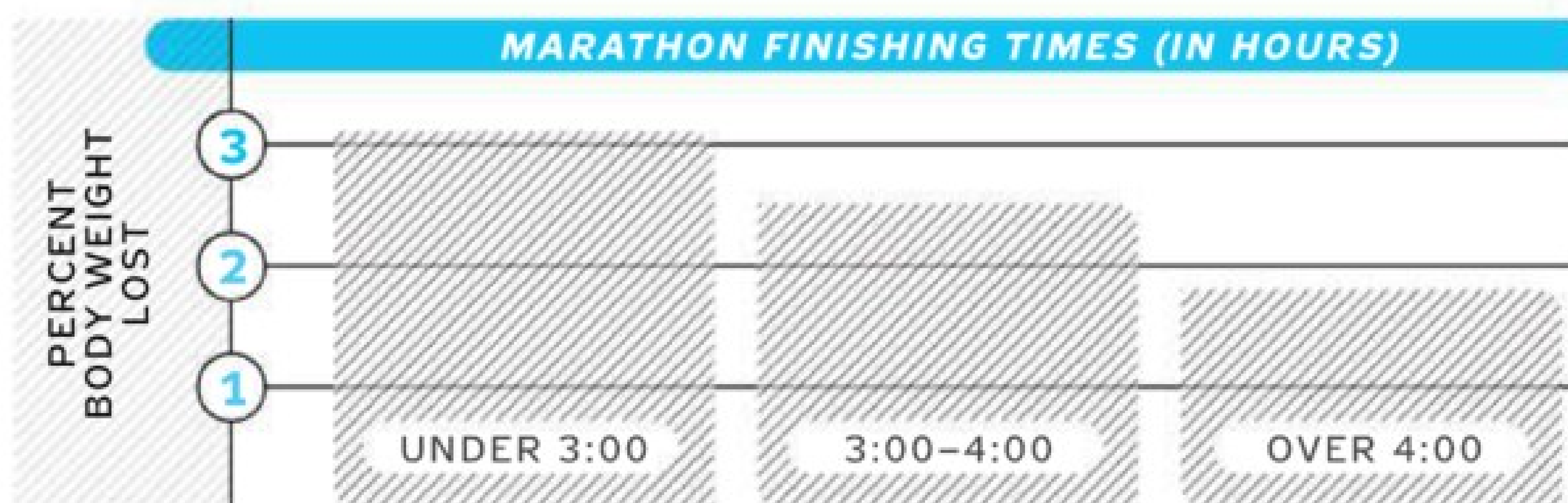
→ Stretching before exercise is a sacred ritual, but researchers have been finding that it actually slows you down. Florida State researchers recently showed that stretching before a run makes you about 5 percent less efficient, meaning you have to burn more energy to run at the same pace. This year, Italian researchers studying cyclists discovered why stretching is counterproductive. They found evidence that toe-touching stretches change the force-transmission properties of muscle fibers and alter the brain signals to muscle, reducing exercise efficiency by about 4 percent. Furthermore, there's insufficient scientific evidence that pre-exercise stretching reduces injury risk.



LOSS OF MORE THAN 2 PERCENT OF YOUR BODY WEIGHT DURING EXERCISE DEGRADES PERFORMANCE →

This debate, popular among exercise gurus and professional trainers, centers on how much water weight an athlete can lose without sacrificing performance. Lab tests have suggested that a body-weight loss of more than 2 percent impairs athletic performance. This information has become accepted. But a study of marathon runners in France published late last year found

exactly the opposite. The fastest finishers were the most dehydrated, having lost 3.1 percent of their body weight, while the slowest finishers lost only 1.8 percent. It turns out that the body has hidden reservoirs that can generate several pints of water during exercise. For example, when your body burns fat or carbohydrates to fuel muscles, one of the byproducts is H₂O. So drinking water when thirsty—and no more—is the best course of action.





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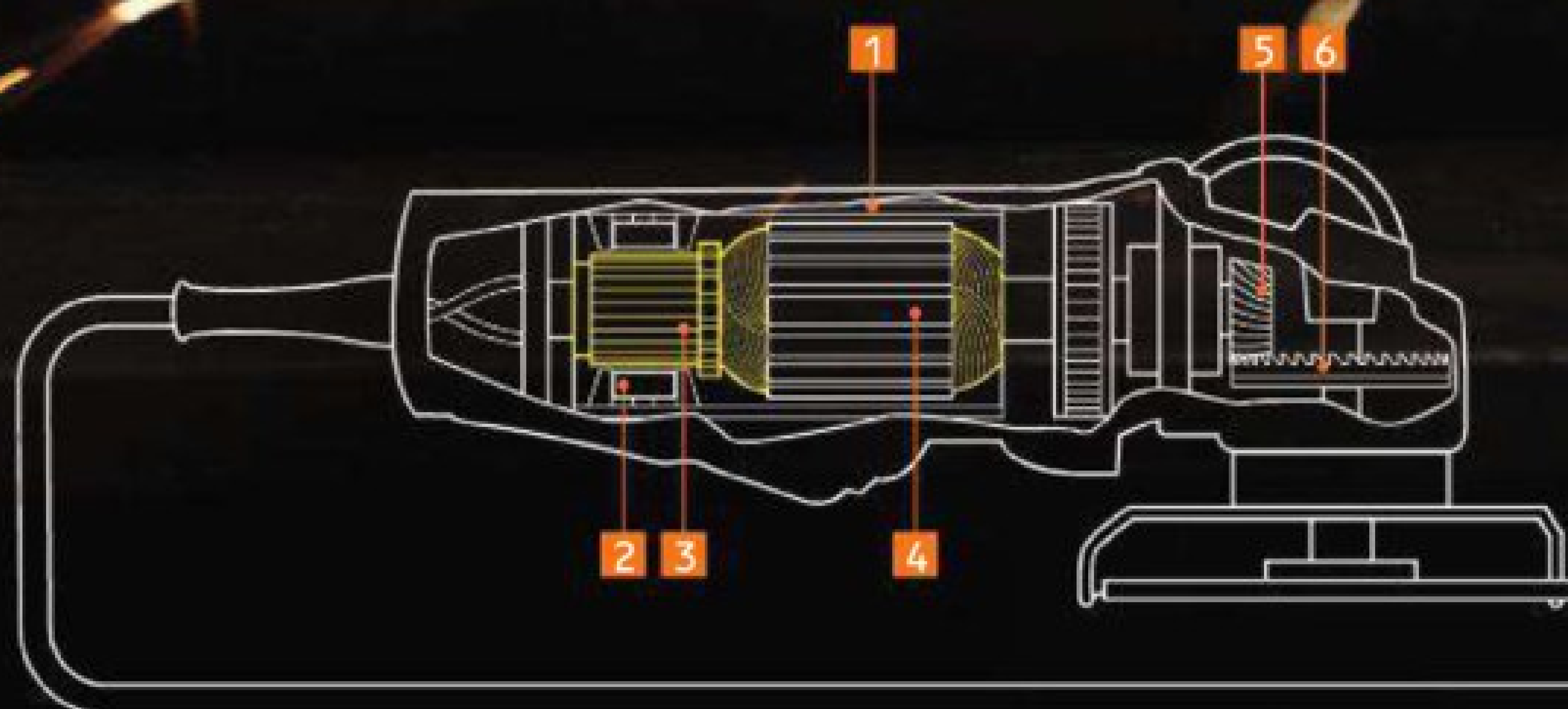
Release: StoreMags & FantaMag

Upgrade

Hot Guts

To create a 4½-inch angle grinder motor, engineers pack copper into a cylinder the size of a beer can. More copper makes a more powerful tool, but dense wire windings fill the can up quickly. For the compact motors in

Milwaukee's eight new angle grinders (from \$120), designers split the can and filled two open halves with enough Cu to crank out 1400 watts, or 50 percent more than average. Two grinders endured a month with Mike Conlon and the metalworkers at Brooklyn, N.Y.'s Caliper Studio. "They're well-balanced, solid tools," Conlon says. "But they get hot." — HARRY SAWYERS



HOW IT WORKS

1 Current enters stator, creates magnetic field.

2 Brushes connect stator to commutator.

3 Commutator's copper bars link to rotor windings.

4 Opposing magnetic fields spin rotor in stator.

5 Rotor spins a pinion gear via mechanical link.

6 Pinion gear turns bevel gear and grinding wheel.

Infinite Playlists

Maybe you don't buy new music, but that doesn't mean you have to steal it. Audio streaming services grant unlimited access to millions of songs for a few bucks a month. Unlike Amazon's Cloud Drive, Google Music and Apple's iCloud, our top five all-you-can-listen buffets don't require uploading or syncing your own collection. Grab all you want; it's yours to keep—at least until you unsubscribe.

BY JOHN HERRMAN

	Rdio	Mog	Rhapsody	Napster	Slacker
MONTHLY COST	\$4.99 Web access; \$9.99 Web, apps	\$4.99 Web access; \$9.99 Web, apps	\$10 Web, 1 device; \$15 Web, 3 devices	\$5 Web access; \$10 Web, apps	\$9.99 Web, apps
CATALOG COUNT	8.5 million	11 million	11 million	12 million	8 million
QUALITY	Undefined "CD quality" for Web, mobile, downloads and streaming	128–320-kbps MP3 downloads; 64-kbps 3G mobile streaming	128-kbps MP3/AAC Web; 64-K AAC mobile; downloads, streaming for both	192-kbps WMA Web downloads and streaming; 64-kbps mobile	128-kbps MP3 Web, Wi-Fi, 4G; undefined AAC quality over 3G mobile
MOBILE PLATFORMS	iOS, Android, BlackBerry, Windows Phone 7	iOS, Android	iOS, Android	iOS, Android, BlackBerry	iOS, BlackBerry, Android, Windows Phone 7, WebOS
OFFLINE	Yes	Yes	Yes	Yes	Yes
SONG CHECK*	12 out of 15	12 out of 15	12 out of 15	10 out of 15	11 out of 15
RUNDOWN	From the minds behind Skype and Kazaa. Strong iPhone and Android apps, but song selection and radio features are so-so. A vibrant blog lists music updates, and robust social networking shows what songs your friends like.	Streaming over 3G bogs down, but Mog's high-quality downloads make up for it. Editors write reviews, rate new music and compose playlists on an extensive blog network. Nice mix of obscure and mainstream music.	The oldest of the streaming services, Rhapsody has aged well since 2001. Restructurings have resulted in odd pricing, and the app can be confusing. Recommendations focus more on Top 40 than hidden gems.	Resurrected from the late-'90s file-sharing service, Napster went legit—i.e., paid up—in 2003. Its massive collection works with a clunky but usable app. Music-discovery tools are simple but shallow.	Initially a radio service like Pandora, Slacker recently added on-demand streaming: Subscribers can search, play and save individual songs and albums. Anyone can listen to smart, free radio stations with preset playlists.

***Song check:** To test selection, we searched for 15 of our favorite tunes, including the Rolling Stones' "Gimme Shelter," Tom Waits's "The Piano Has Been Drinking" and Golden Earring's "Twilight Zone."

Radio Revival

→ On-demand music apps top the download charts, but smartphones and tablets are breathing new life into analog radio. Here are three new ways to hear old-school broadcasts.

TuneIn


With thousands of live local radio station broadcasts worldwide—plus TiVo-style recording and station schedules—this app out-radios the radio. Listen in on Georgia from Atlanta to Tbilisi.

WunderRadio

Hear a jazz station in Senegal tonight or tune in to historical broadcasts from the last century. Eavesdrop on the criminal underworld with countless police scanner streams. If it's on the air, it's probably here.

Stitcher

A massive podcast repository, this app trumps iTunes as a DIY way to compile online and analog talk-radio feeds. Pair Fox News and NPR, for instance, to build your own customized chatterbox.



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VICTORY

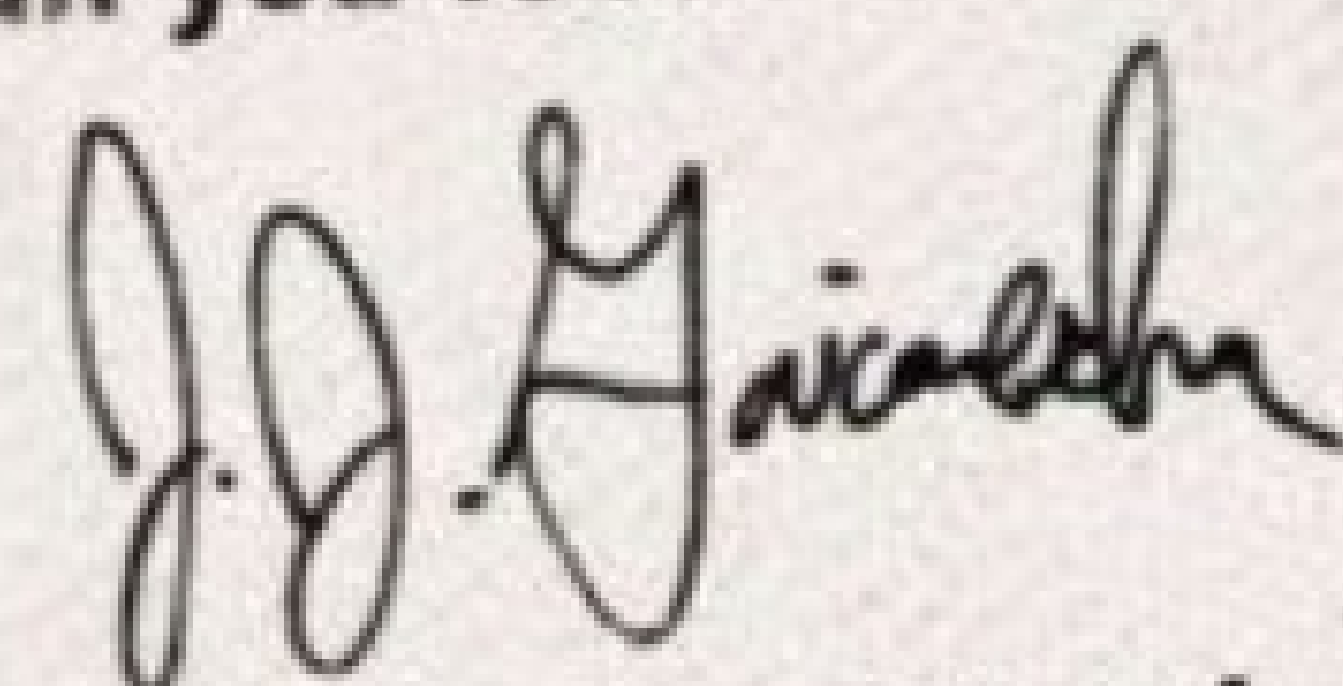
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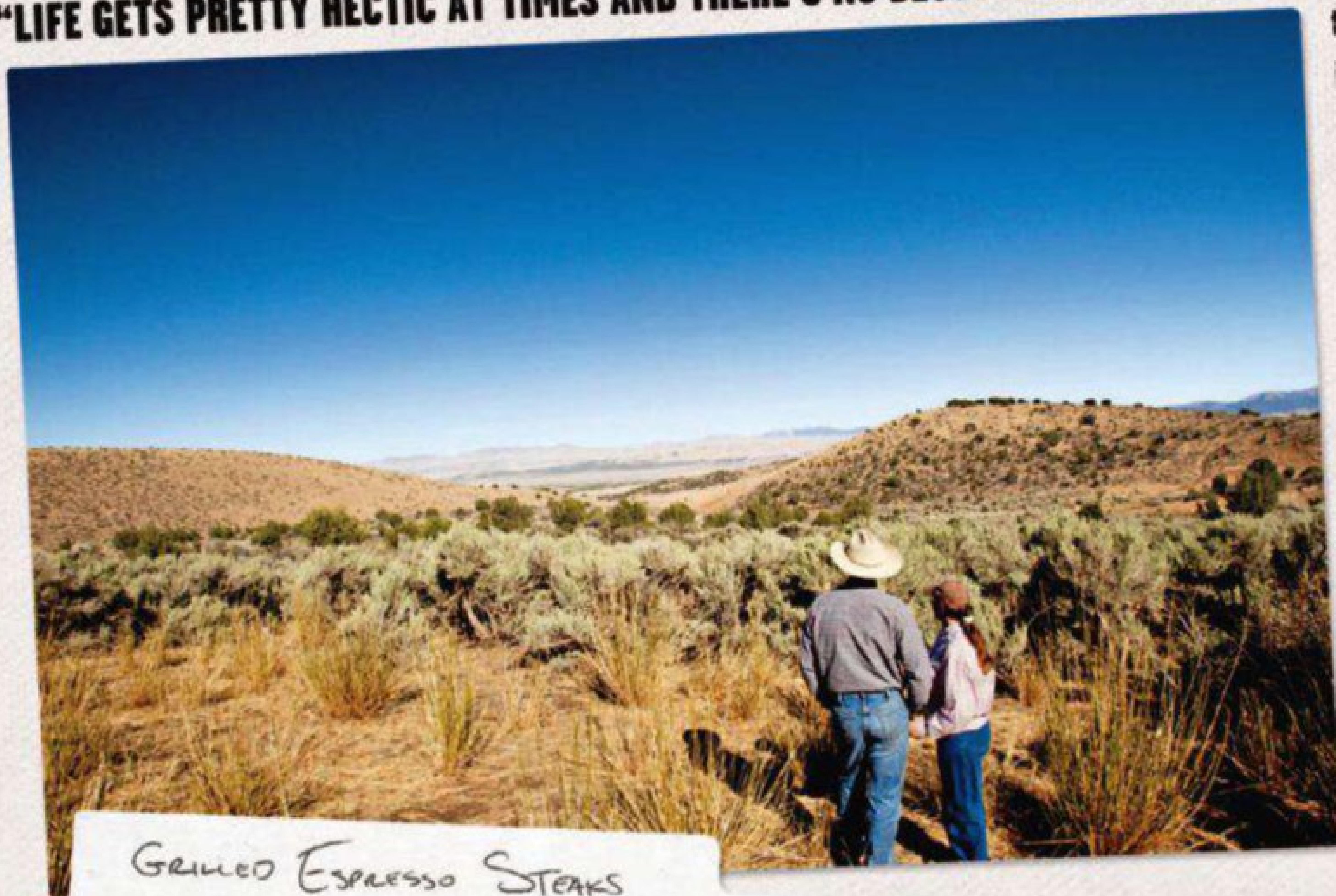
FROM OUR TABLE TO YOURS

"LIFE GETS PRETTY HECTIC AT TIMES AND THERE'S NO BETTER PLACE TO BE THAN ON THE RANCH. The main

thing I like about this place is just the peace of mind. Nevada is different. It's wide-open spaces. I like getting out there, just me and my family. You don't worry about your phone ringing, and you're not worried about email or anything else. You're just taking care of the land and the ranch and that's all you focus on."

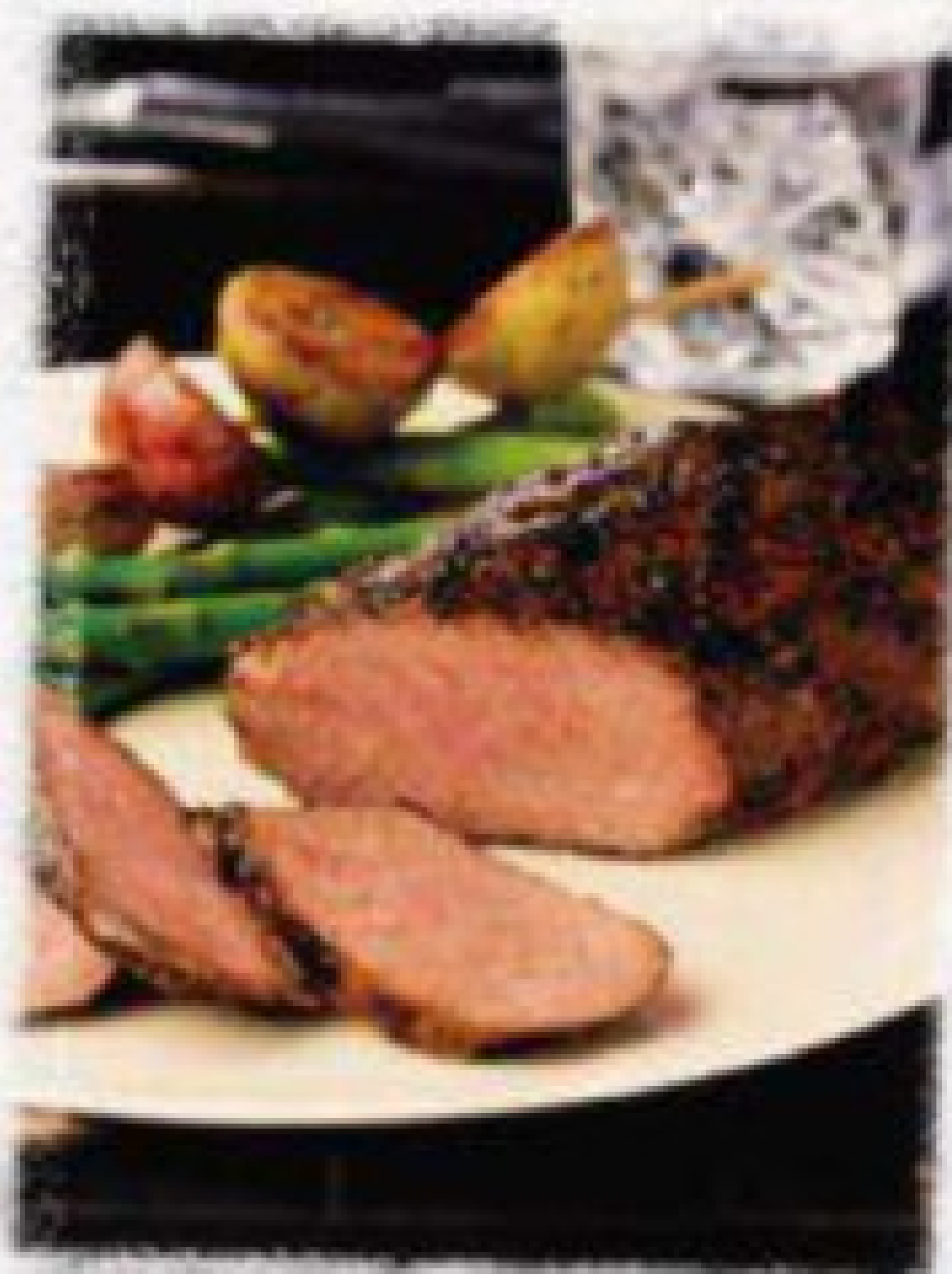


Goicoechea Ranch
Nevada



Grilled Espresso Steaks

A GOICOECHEA FAMILY FAVORITE GRILLED ESPRESSO STEAKS



Total Recipe Time: 35 minutes

4 beef tri-tip steaks, cut 1 inch thick
(about 6 ounces each)

Salt

Green onions, lemon wedges, freshly grated
lemon peel (optional)

Espresso Rub:

2 tablespoons finely ground espresso coffee beans
1 tablespoon garlic pepper
2 teaspoons brown sugar
1 teaspoon ancho chili powder

1. Combine espresso rub ingredients in small bowl; press generously onto beef steaks. Discard any remaining seasoning mixture. Place steaks in glass dish. Cover and refrigerate 1 hour.
2. Place steaks on grid over medium, ash-covered coals. Grill, covered, 10 to 14 minutes (over medium heat on preheated gas grill, covered, 10 to 14 minutes) for medium rare (145°F) to medium (160°F) doneness, turning occasionally.
3. Carve steaks into slices. Season with salt, as desired. Garnish with green onions, lemon wedges and lemon peel, if desired.

Makes 4 servings

Nutrition information per serving: 252 calories; 11 g fat (4 g saturated fat; 5 g monounsaturated fat); 91 mg cholesterol; 403 mg sodium; 3 g carbohydrate; 0.1 g fiber; 34 g protein; 10.5 mg niacin; 0.7 mg vitamin B₆; 1.9 mcg vitamin B₁₂; 2.4 mg iron; 41 mcg selenium; 6.3 mg zinc.

This recipe is an excellent source of protein, niacin, vitamin B₆, vitamin B₁₂, selenium and zinc, and a good source of iron.

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*Biking With Cargo:***A Schlepper's Guide**

New gear to help bikers haul a load solves the major drawback of commuting on two wheels—there's no truck bed, trunk or back seat where you can put your stuff while you ride. Bike storage is evolving, with bulk-capacity baskets and vehicle designs reminiscent of rickshaws. But as anyone who has tried to pedal home a sheet of plywood can attest, there's still room for innovation. — IAN LANDAU

**MAKE YOUR BIKE HAUL**

Trailer ↓ Boise, Idaho's *B.O.B. Yak Trailer* (\$329) carries up to 70 pounds on a 25 x 16 x 18-inch bed. Its slim one-wheel frame attaches to the rear axle, which allows for easy removal and keeps the center of gravity low for better stability.

Rear Rack ↓ The *Topeak Explorer* (\$35) mounts above the rear wheel. For bulkier loads, Xtracycle's *FreeRadical LiteLoader* (\$364; above) has panniers with waterproof flaps and a roomy deck to cart, say, folding beach chairs.

REAR





Cetma Cargo (\$1850, frame set only)

The biking equivalent of a family SUV, the made-in-Oregon Cetma Margo (left) has an 18 x 27-inch deck suitable for errands. Step up to Cetma's Largo model and the deck grows 6 inches wider and deeper, big enough for the optional box that'll fit two kids side by side—arrive at the soccer field in style.



Torker Cargo-T Bicycle (\$600)

With a Sturmey-Archer internal five-speed, drum brake and 45-pound capacity on front and rear racks, the Cargo-T deftly handles medium-grade hauling. The center-mounted stand and locking headset make for stable parking; mounting and dismounting are a breeze with the step-through frame.

The Mule by Naked (\$3500)

Displayed as a prototype at February's 2011 North American Handmade Bike Show (NAHBS), the Mule employs a 20-inch rear wheel, lowering the back load's center of gravity for greater stability. The rear end is also designed to accommodate Xtracycle's supersize panniers, as shown here.



Gallus Cycles Travel Grinder (\$4500)

Texas bike builder Jeremy Shlachter designed this two-wheeler to be disassembled (the front rack simply folds to the side) and stowed in luggage that fits in an airplane's overhead bin. The custom build, a hit at NAHBS, is perfect for a career courier seeking a bespoke fit.

Saddle Bags ↓ Ortlieb's waterproof saddle bags, like the **Back-Roller Classic (\$165/pair; below)**, hold up to 2441 cubic inches of cargo. **Arkel's Dolphin 32 Panniers (\$179/pair)** clip to a rear rack and expand to capacity.



Back Box ↓ Zip-tying a milk crate to the rear rack adds a sturdy cargo hold. Collapsible rear baskets like **Eleven81's Basic Rattan Version (\$25)** or **REI's Novara 'Round Town Basket (\$30; below)** are more portable than a crate.



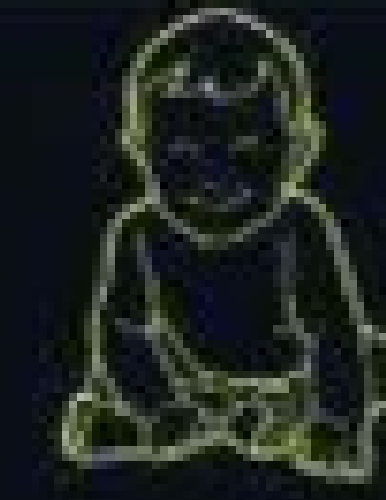
Front Basket ↓ Light loads like groceries ride up front in baskets that cost as little as \$20. Higher-quality options include the **Cetma Cargo BRACK Basket/Rack (below)**. The basic model goes for \$200; add a removable rail for \$35.



FRONT →

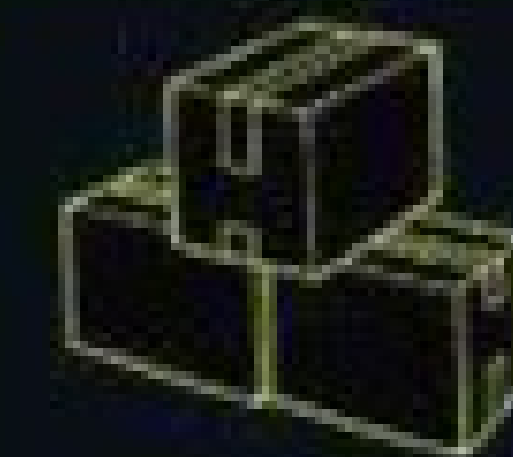
Three Big Loads

1. DELICATE



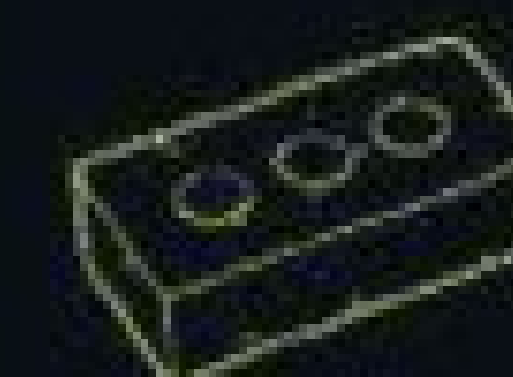
"Small kids are better carried upfront," Brunhilde Vergouwen, manager of Brooklyn, N.Y.'s Rolling Orange bike shop, says. She recommends the Bobike Mini (\$140) or Yepp Mini (\$140), both of which carry children of up to 33 pounds. A rear seat like the CoPilot Limo (\$115) can carry 40 pounds. For tykes nearing the 70-pound mark, Bobike's Junior (\$215) can carry the precious cargo and—sans kid on board—folds down to become a rear storage rack.

2. BULKY



When hauling an awkward, multiple-item load, a low center of gravity is key. Pack heavier items on the bottom of panniers, racks, baskets or boxes. High winds can turn bulky, lightweight cargo into a sail; slow up to avoid being blown off course by big gusts.

3. HEAVY



Use extra caution when approaching intersections and other braking situations when laden with a heavy load. A bike packed with weighty cargo needs plenty of room to decelerate and come safely to a stop.

ABUSIVE LAB TEST

Storm Jackets

Gore-Tex is the iPhone of outdoors clothing: an annoyingly dominant player with a target on its back. Our sweat-prone team tested jackets showcasing three ultra-breathable, waterproof (and pricey) technologies—one from the big guy and two from powerful challengers. *BY HARRY SAWYERS*



Columbia Flyin' Dry (\$250)



Adidas Outdoor Terrex (\$395)



North Face Jammu (\$399)



Tech Contenders

Fabric engineers don't compete on "waterproof" anymore; they wrestle over breathability and factors such as weight savings.

FLYIN' DRY: Omni-Dry—a 2.5-layer fabric composed of a burly outer material paired with a highly breathable waterproof membrane and feathery lining—appears only in Columbia Sportswear garments.

TERREX: Active Shell jostles into the Gore-Tex line as the company's most breathable product. Several high-end clothing makers use it.

JAMMU: Fleece meets rain jacket here. Polartec's NeoShell sandwiches a waterproof breathable membrane between a tough face fabric and a soft inner layer.

Sweat Stroll

We wore each jacket in the worst-case scenario for breathability—on a brisk sidewalk stroll during a steamy summer storm.

FLYIN' DRY: The jacket breathed well and felt good—but beware of downpours. It's designed for hood-hating cyclists and runners—if that's not you, choose a different Omni-Dry product.

TERREX: This was more breathable than Gore-Tex jackets we've tested before. We liked the big, helmet-friendly hood, but sleeves this long are best suited to ice climbers or gorillas.

JAMMU: The Jammu combines stretchy, fleecy comfort with tight weatherproofing. For spring and fall, it could be the favorite jacket in an outdoor geek's quiver.

Hose Test

To simulate driving rain (and, frankly, for fun), we turned the hoses on PM intern Lester Black.

FLYIN' DRY: With no hood, Black got soaked. But seams and zippers held up to the hard-driving jet.

TERREX: Thanks to a stiff bill and multiple drawstrings, the hood fought off our simulated torrent.

JAMMU: Black received exemplary weather protection—but no fleece jacket is ideal for a summer day: "A Thermos," Black called it.

BOTTOM LINE

Jacket tech truly has advanced this year. But you don't wear a fabric, you wear the entire jacket. The Columbia jacket can't be beat for breathability, but it's purely for cyclists and runners. The Jammu is an innovation star. But at these prices, one jacket should work in all conditions: Adidas wins.

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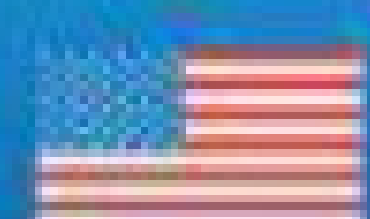
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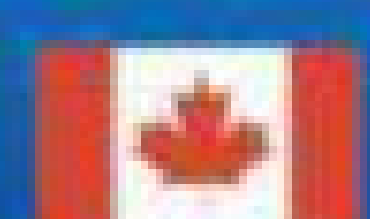
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INTO THE GREAT WILD OPEN

Although camping can be one of the most rewarding and memorable outings you can experience with your family and friends, preparation is essential for a successful adventure into the great outdoors. The necessary equipment and supplies can make all the difference in keeping numerous gear failures at bay. If you breach the discomfort threshold, you'll find kids are in tears, and spouses will be yearning for a hotel.

To avoid displeasure, here are some rules, tips and lists to camp comfortably while looking like an outdoor hero.

THE TOP 10+ ONE

THERE ARE ENDLESS QUANTITIES OF GEAR THAT CAN BE BROUGHT ON A CAMPING TRIP. HERE IS A SHORT LIST OF ELEVEN ITEMS THAT HAVE PROVEN TO BE INDISPENSABLE FOR MOST.

- A first aid kit
- A 20x20 sheet of 6mm plastic
- Duct tape
- Compass (even if you carry a GPS)
- Multi-tool
- Waterproof matches
- Fire-starting kit with a lighter
- Rope
- Axe
- Tent cord
- Flashlight



DARK & STORMY



The first and most-overlooked variable is weather. Don't rush to cancel a weekend trip to the woods because of a shower in the forecast. A quick, detailed look online will allow you a clearer weather view. However, heavy thunderstorms or long-soaking rains could send a signal that it may be worth re-evaluating your schedule and moving the trip to another weekend. Due to rising water levels, take special note of these issues when camping near a river or if your weekend involves boating or canoeing.

TIP

Something as simple as a tarp, large rain fly or "party tents," can be the shelter that keeps everyone out of the mist while also providing a place to cook and congregate if the sky turns sour.

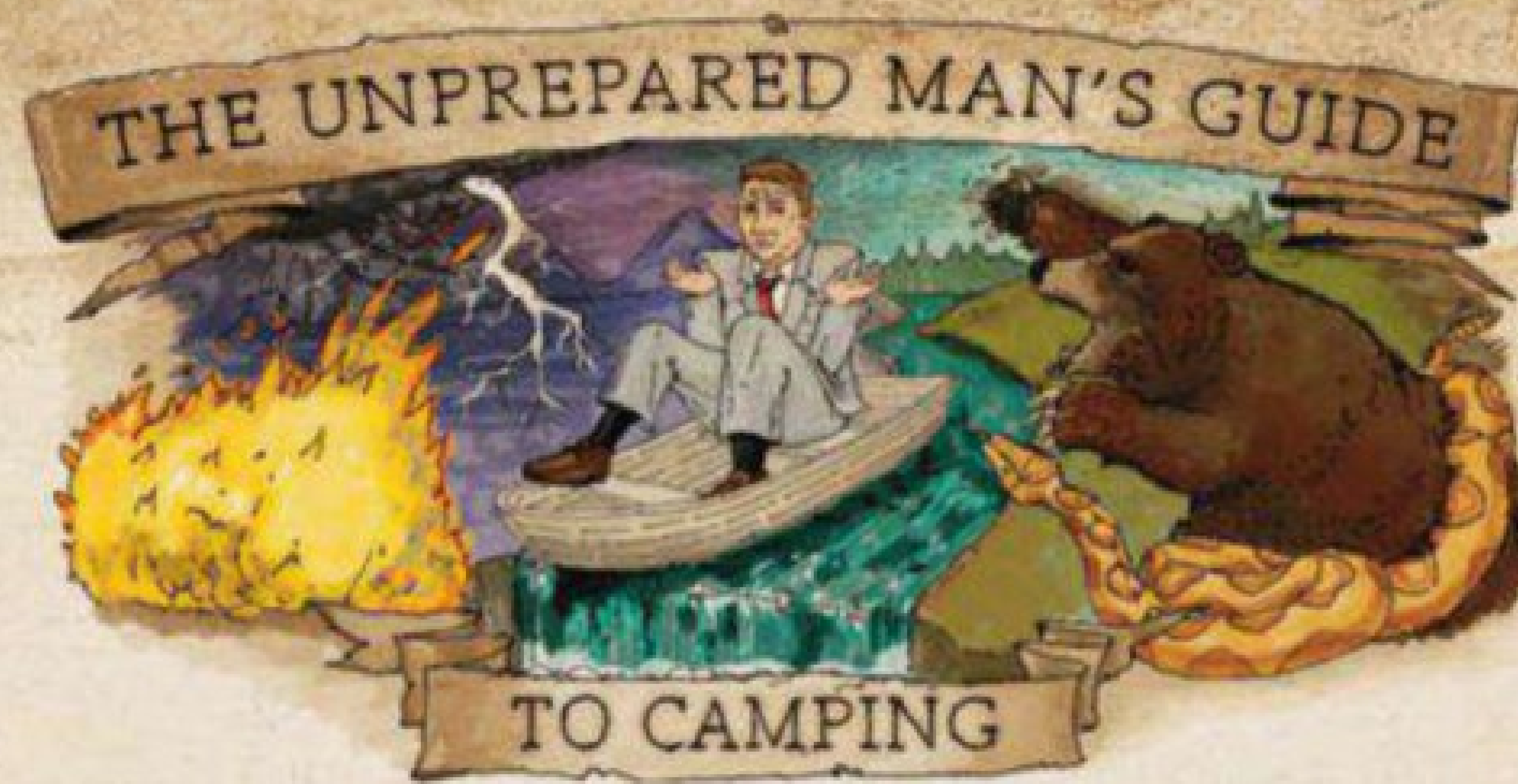
A BETTER NEST

Everyone needs a good night's sleep and a cot, or at the very least, a cozy ground pad will improve the disposition of each camper.

As for sleeping bags, when in doubt, go large. A comfortable rectangular bag will offer a far better night's sleep than the mummy bag you backpacked in during your early twenties.

TIP

If hot weather is the rule, some people will bring a sheet and a light fleece blanket to rest in. As the temperature climbs, this combination will breathe far better than a heavy bag. Also consider investing in a light summer bag. They are usually inexpensive and can be used by kids around the house the rest of the year.



THE MAN NEST

Mother Nature is not only an inspiration to painters and makers of motivational posters. She can also provide important cues for outdoor survival. If you've skipped your visit to Gander Mountain and find yourself tentless, take a little advice from your fine feathered friends.

WHAT YOU'LL NEED:

4 to 6 large fallen branches
Ample dead grass and dry leaves
1 jacket or sport coat

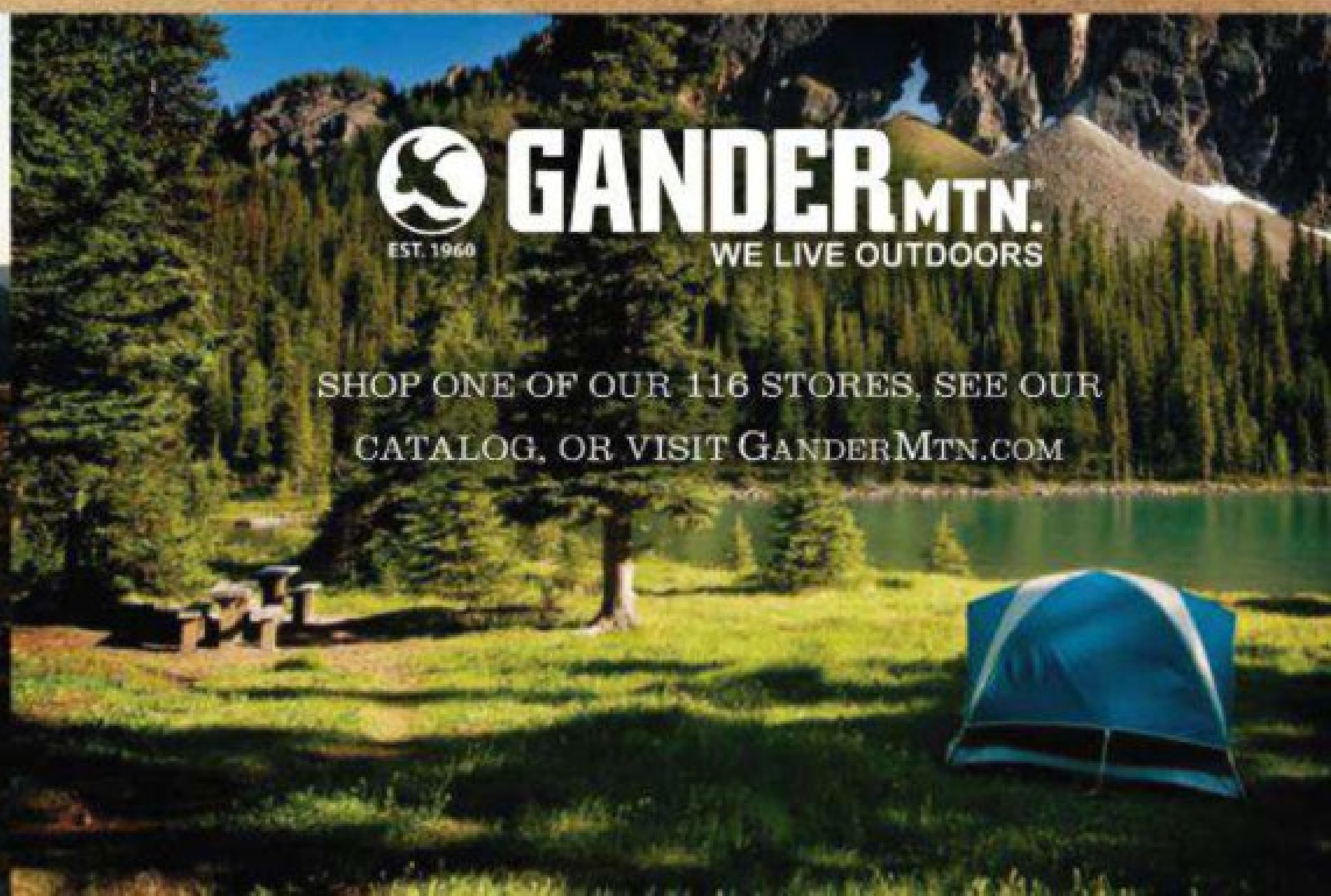
INSTRUCTIONS:

- 1) Find tree with wide, horizontal branch at least 7 feet from ground.
- 2) Create "bedding" of leaves and grass, using branches for additional support.
- 3) Intersect remaining branches into lower bedding, creating domed covering.
- 4) Patch openings with leaves and mud (*Fig. 1*).
- 5) Drape jacket over portico.



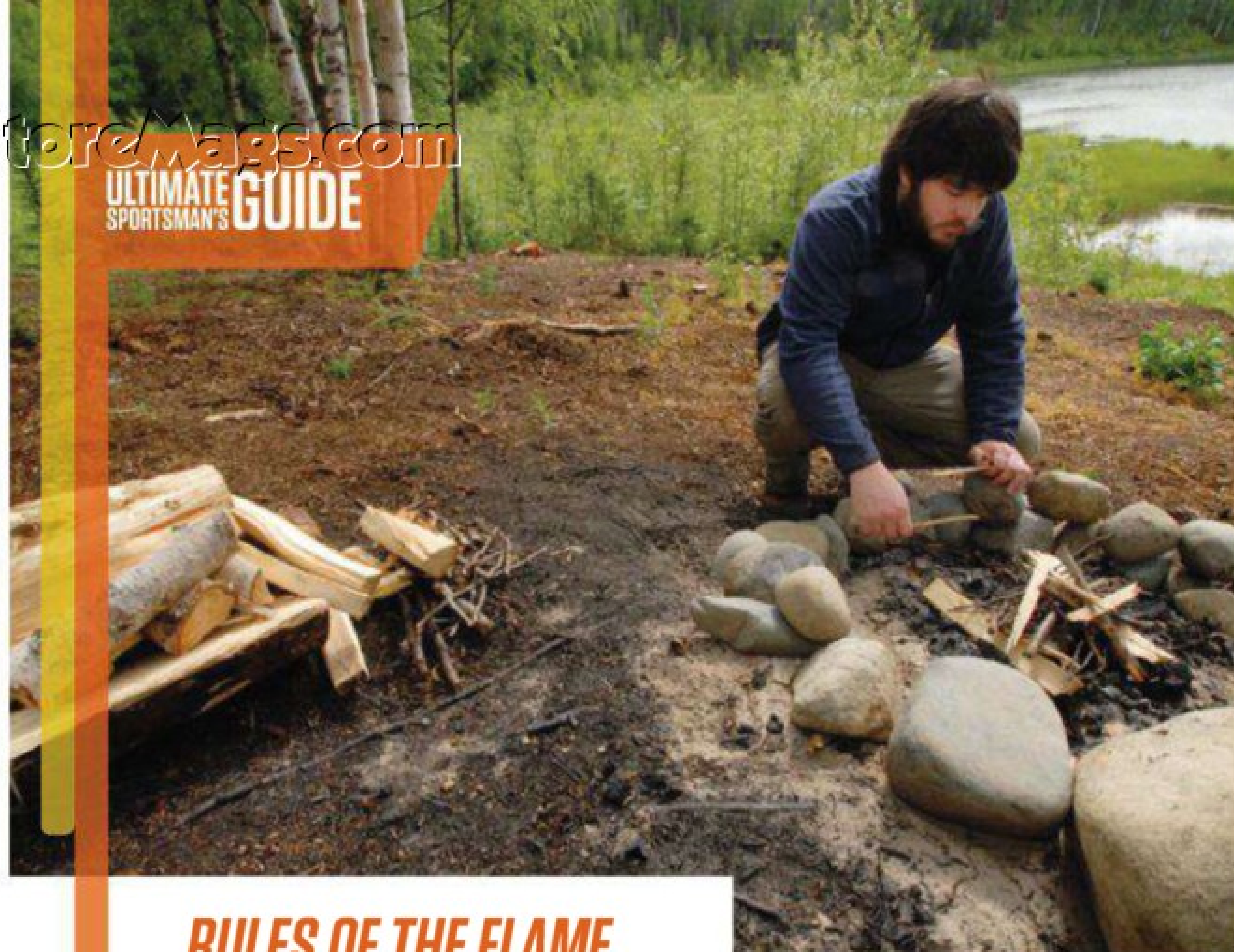
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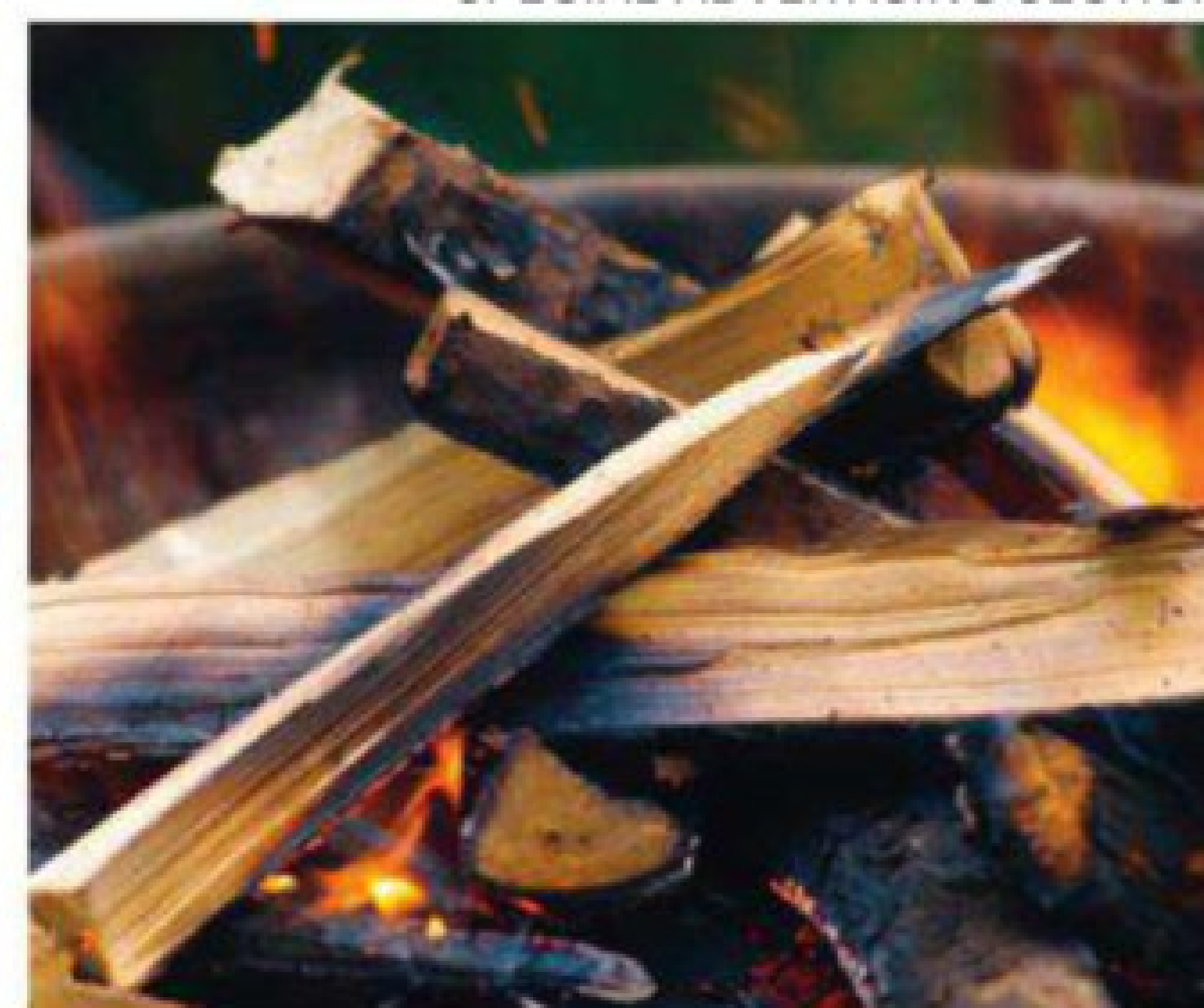
RULES OF THE FLAME

There are few activities as primal and essential as being able to start a campfire. Many campers feel that if a campfire is not part of the mix, they just haven't had the whole camping experience. Burning embers are the social focal point for the group, providing warmth, emotional comfort and hot food, and they serve as an excellent bug deterrent.

Keep in mind, that some states limit the transportation of local trees to other areas or states because of the threat of spreading invasive insects. Always check local regulations to

see if fire permits are required. Also be aware that if you're camping off a hiking trail in most national forests, you must set your camp and fire away from the trail. Check at the trailhead for exact distances.

Gasoline should never be used as a fire starter. The fumes are highly explosive, and singed eyebrows could be the least of your problems. If you must use fuel as a starter, consider diesel. It can initially be difficult to light, but always be cautious, use sparingly, and never light with a match in hand.



TIP

Being able to start a fire in poor conditions requires some planning. Keep some of these tricks in mind on your next trip:

Even in a driving rain, the bark from birch trees will start a fire.

Always carry an extra lighter and matches in a waterproof container.

Household items like dryer lint make excellent starter-tinder.

Pinecones are perfect fire starters, and if they have a sap residue they will also work in wet weather.

Paraffin wax melted onto sawdust, small sticks, old hemp rope or cotton balls works wonders to get flames going in the rain.

The most powerful fire starter in severe wet conditions is a road flare. Pile up a stack of the wettest wood in the forest, crack a flare, and you'll have a blaze without tinder in just two minutes. Just make sure you follow the directions on the flare.

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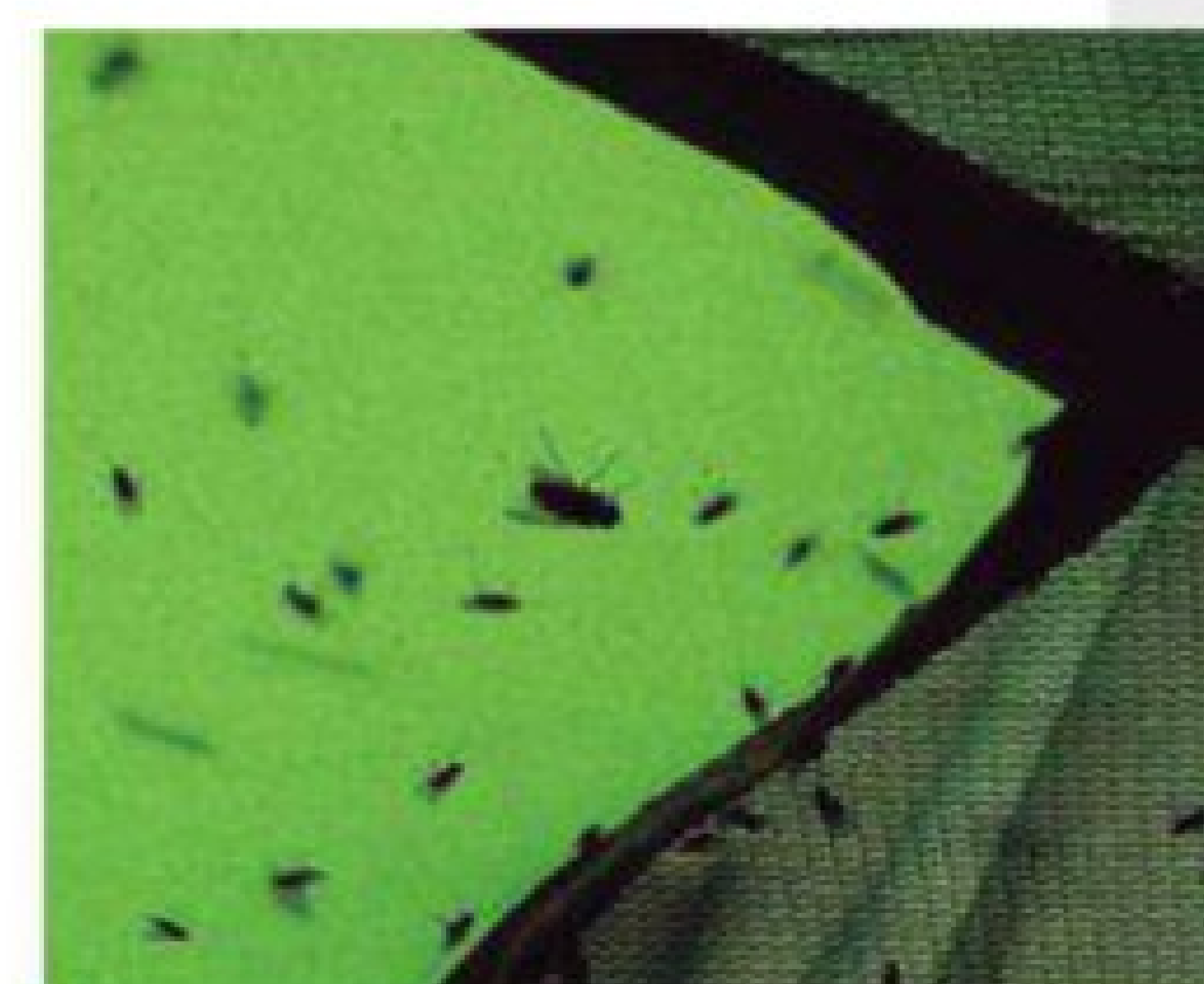
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HANDLING BUGS

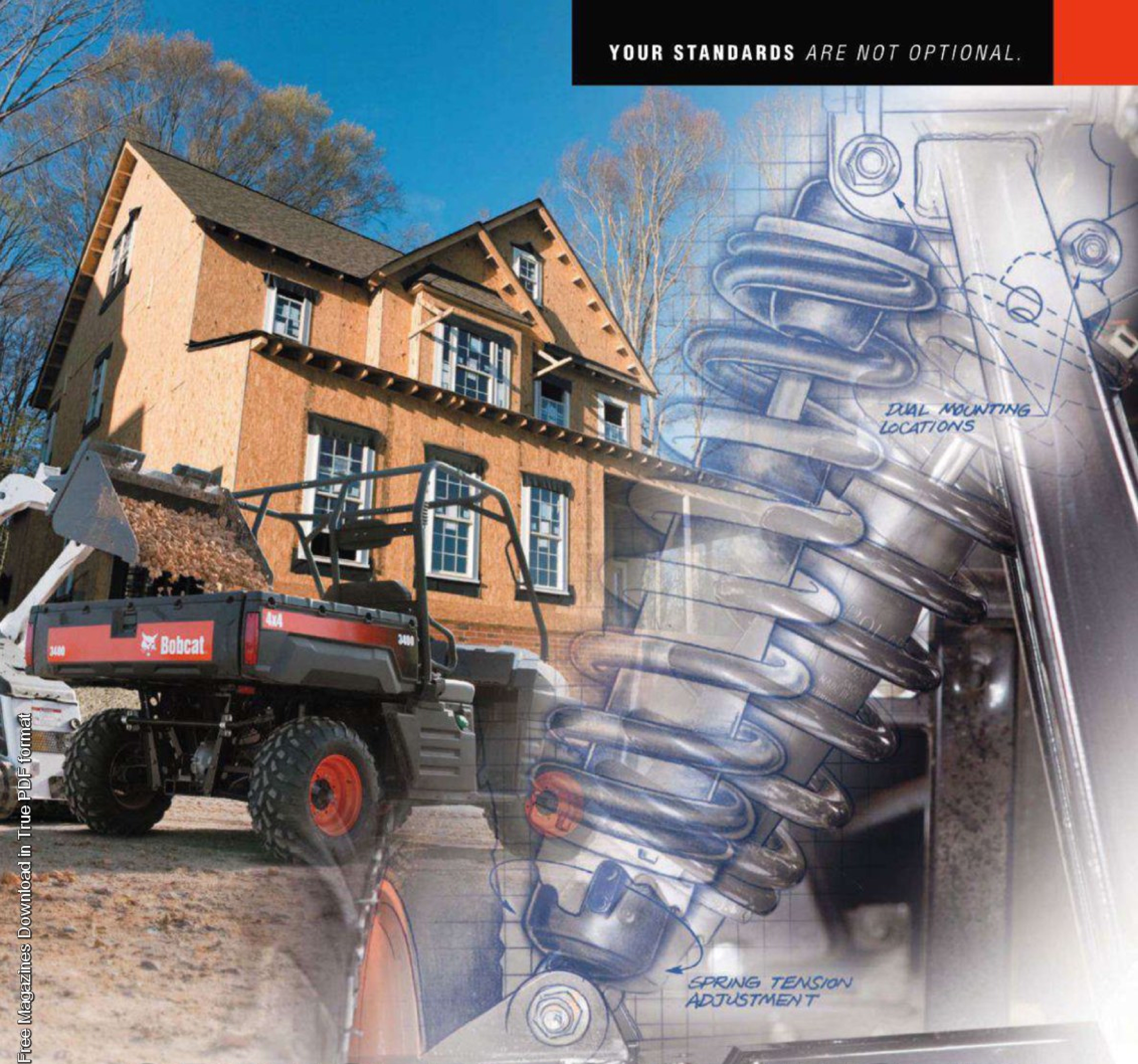
There is no faster way to send kids and spouses scurrying for new accommodations than letting the bugs get out of control.

Although sprays can work well (especially for ticks), consider a propane bug trap or a butane repellent device. The handhelds sell for about \$25, work wonders without putting chemicals on the skin and take up very little space. They are so effective, you'll probably use them on the deck at home during bug season.



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One Tough Animal™

Release: StoreMags & FantaMag

ULTIMATE GUIDE



FIRST RIDE

Adding an ATV ride to your camping mix can heighten the fun factor of any outdoor experience, especially for the first-time camper.

As with any powered machine, basic ATV skills are imperative for safe operation. Although most owners have good equipment and are careful with new riders, you need to keep it safe.

Here's a short list of the basics to do just that:

Everyone needs to wear a helmet.

Riders must be at least 16 years old to ride a full-sized machine over 110cc's.

For additional protection, wear gloves, eye protection, jeans or work pants, and boots.

Avoid pavement. ATV's are not designed to drive on blacktop surfaces and can react erratically even when in experienced hands.

When going up a steep hill, lean forward toward the handlebars.

When descending, lean back toward the rear end.

If your bike is traveling across the side of the hill, lean toward the higher hillside.

Do not go any faster than you are comfortable traveling.

THE AFTERMATH

Camping gear can attain some robust odors by the time you travel home. And, if rain was involved, it can be far worse, creating mold that will damage your gear in storage.

If your tent was rolled up dry, then it's good to go and ready for the next outing. If the weather was not ideal or the tent was rolled up with dew on it, rinse it off with a hose when you get home and let it dry completely before rolling it up. If you have to, use the garage to dry the tent, but don't put it in the dryer. The intense heat can be too much for some of the sensitive fabrics.

Sleeping bags, windbreakers and most jackets can be tossed in the washing machine. Make sure that you use a detergent that rinses clean. If the package doesn't say "clean rinsing" or "no residue," it won't. If the right detergent isn't on hand, wash the gear in warm water with one quarter of the amount of your regular detergent while adding an extra rinse to the final cycle.

TIP

In most cases, rainwear should be tossed in the dryer, and the heat will help restore the DWR (Durable Water Repellent). That's the stuff that makes water bead up on your jacket and gear. Check the label on the item to ensure the dryer is appropriate.

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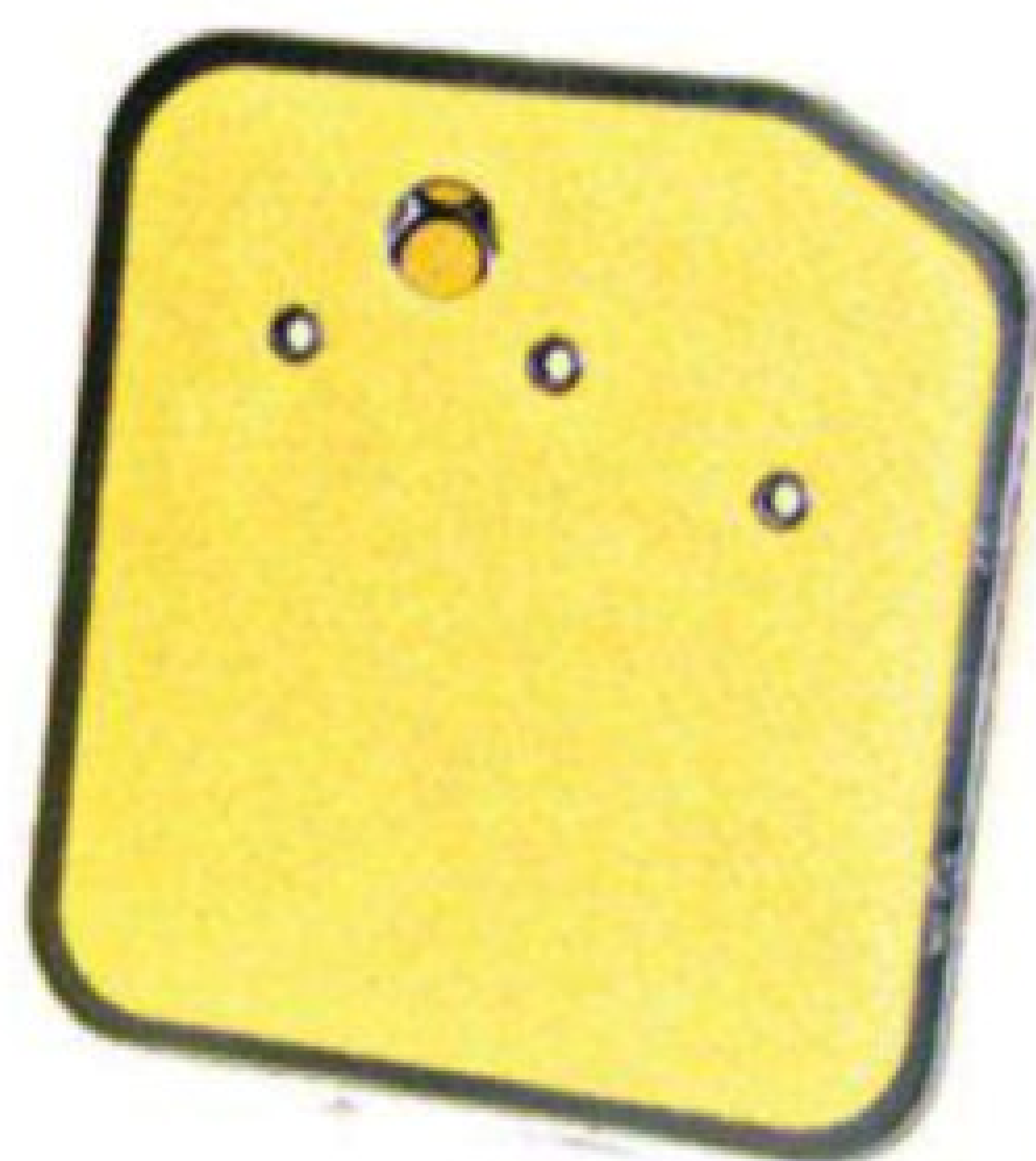
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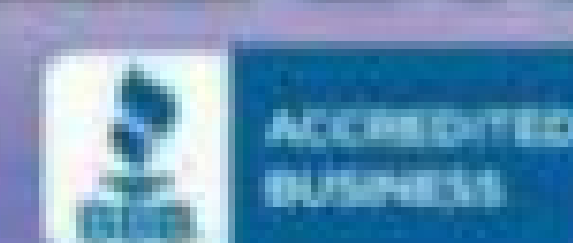


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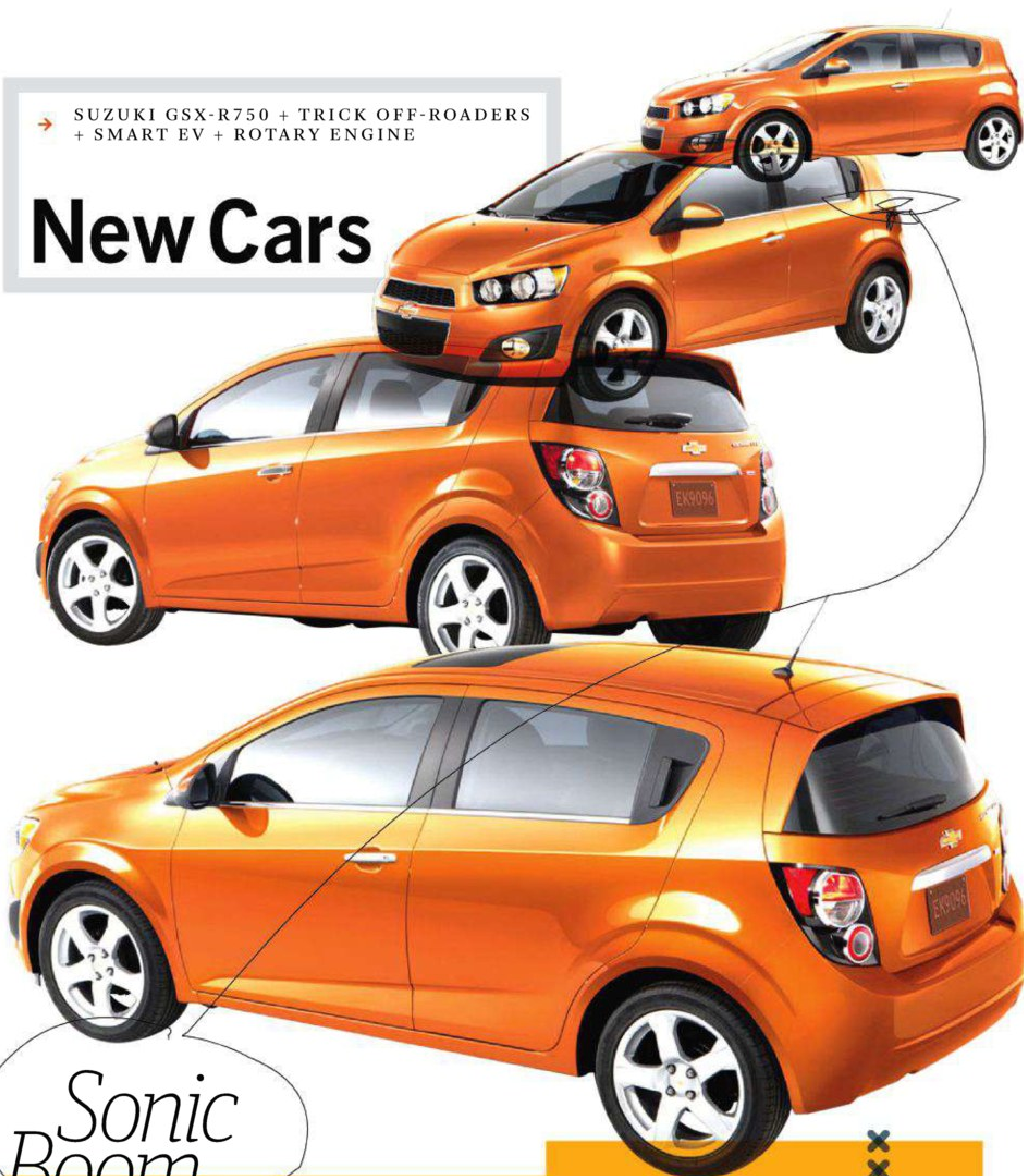


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New Cars



Sonic Boom

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Small cars are no longer an afterthought at GM. First came the surprisingly slick Cruze, and now the diminutive Sonic arrives this fall. The four-door sedan or hatchback replaces the Aveo, a rebadged Daewoo that was such a dreadful piece, it's no wonder Chevy gave its new tiny tot a fresh name. Two four-cylinder engines—a 1.8-liter or a turbo 1.4—reside behind a distinctive row of four exposed headlights that suggests the designers worked to give this economy car some

style. Its inside is simple but attractive, and there's room for a pair of 6-footers in the rear seat. Plus, the Sonic is a terrific drive. The structure feels tight, the suspension shakes off midcorner bumps with aplomb, and the electrically assisted steering requires just the right amount of effort. A well-loaded ride, with nearly everything except a nav system, will run about 20 grand, but you won't feel like you're driving a cheap car. — LARRY WEBSTER

2012 Hyundai Accent



STRONGER ACCENT ▶ Pioneering with direct fuel injection in the entry-level category gives the new Accent (\$13,205) class-leading power and impressive 30-mpg-city/40-mpg-highway ratings. The 1.6-liter motor delivers 138 hp and 123 lb-ft, smoothly and quietly. There are six speeds whether you choose the manual or the automatic transmission. It easily cruised the highway with three adults aboard, even up hills in 107 F Nevada heat with the a/c on full-blast. Both the hatchback and sedan versions offer adult-size rear seats and new "fluidic sculpture" design that stands out. There are more compact competitors than ever, many offering richer flavor than found in the Accent, but buyers who want ease of use, a comfortable ride and a strong warranty will make the comparisons and take this one home, if not to heart. — KEVIN WILSON

2012 Audi R8 GT



KILLER R8 ▶ The new R8 GT is a very expensive, and very limited, lightweight edition of Audi's supercar, with a hopped-up version of the V10 that screams out 560 hp. The engine is paired to an automated six-speed gearbox that's controlled by a sculpted shifter fit for MoMA. Naturally, the R8 GT is ludicrously quick, and it handles too. Flick the paddle shifter for a lower gear, dig deep into the power and the motor snaps to attention, gloriously wailing behind the occupants. Firmer suspension and grippier tires amp up cornering. Yet this brutally effective speed merchant has polish. The interior is a delicious mix of Alcantara and carbon fiber and retains the luxury features—air conditioning, navigation, etc.—that you'd expect for your \$196,800. A very sinister flat-gray paint job is available, but that's another \$6000. Hey, it's only money. — BEN STEWART

Gentleman's Express

▶ You can't change the weather, and, sadly, our time behind the wheel of Mercedes' intensely fast CLS63 AMG (\$94,900) came during an all-day downpour. So, every acceleration brought on the traction control or the stability control. A twin-turbo V8 will do that. The new 518-hp 5.5-liter engine replaces the naturally aspirated 6.2-liter mill and ups output while reducing fuel consumption by more than 25 percent. Specify the AMG Performance package and the boost goes to 18.8 psi, and power to 550 hp. We particularly liked the instantaneous upshifting and downshifting of the MCT (Multi-Clutch Technology) transmission and the lively, free-revving nature of the entire powertrain. The drivetrain is all-new, and the body has received a major restyling, with sculptured fenders, a lower roofline and a slightly longer wheelbase for more rear legroom. One thing we didn't really get a chance to test are the world's first active LED headlights, which swivel into corners as you turn the wheel, illuminating farther around the turns than the best conventional headlights.

— MIKE ALLEN



2012 Mercedes-Benz CLS63 AMG

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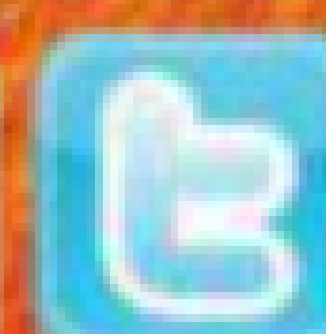
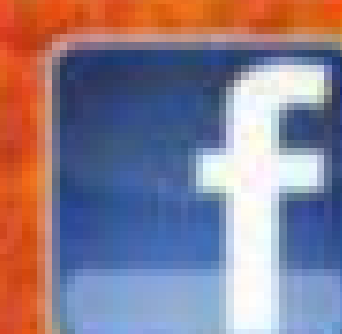
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2011
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Textbook Superbike



Tiny 0.75-liter engine produces over 100 hp and revs to 14,000 rpm

The swing arm loses 2.9 pounds

► An encyclopedic description of the modern superbike would probably be accompanied by a picture of the Suzuki GSX-R750. The original crotch rocket appeared in 1985 and has since inspired a 600-cc spinoff and an even more potent 1000-cc variant. For 2011, the \$11,999 Suzuki GSX-R750 gains a gang of race-bred improvements, among them a broader powerband on the still wildly powerful engine, a shorter wheelbase with more aerodynamic bodywork, and a 17-pound weight loss that brings curb weight to only 419 pounds. The 750 may lie in the shadow of the company's literbike—the version with a 1.0-liter, more powerful, motor. But considering how fiercely we ripped the GSX-R750 through the epic canyon roads of Angeles Crest Highway outside Los Angeles, we're completely content with the capabilities of this angry but balanced little Gixxer. — *BASEM WASEF*

2011 Lotus Evora S



BLOWN CARVER ► Lotus founder Colin Chapman earned notoriety and achieved unprecedented racing success by enforcing his mandate to "add lightness." But the \$77,175 Evora S achieves win-win performance benefits by bolting a supercharger to its Toyota-sourced 3.5-liter V6, which now churns out 345 hp and 295 lb-ft of torque. Those figures don't sound impressive in this age of 600-hp Corvettes. But when the whole package weighs just 3168 pounds and the suspension is tuned as exactly as the Evora S's, the resulting on-road manners are nothing short of sublime, as we experienced at California's Mazda Raceway Laguna Seca and the surrounding sinewy roads. Die-hards might grouse that the Evora S is still too porky for the famously lightweight brand, but with a heavier generation of Lotuses just around the corner, the Evora S offers a gratifying combination of luxury and performance. — *B.W.*

2011 Smart Fortwo ED



SMART CHARGING ► Smart is leasing 250 Fortwos, Electric Drive (ED). Cost? Four years at \$599 a month. Apart from the powertrain conversion, the Fortwo EDs are nearly identical to their gasoline counterparts. The pack is a 16.5-kwh lithium-ion unit by Tesla Motors that weighs 326 pounds and provides an estimated range of 84 miles. The electric version does away with the gas version's slow-shifting gearbox—there's just one ratio—but it's even slower. A run to 60 mph takes about 20 seconds, and it tops out at 62.5 mph. So its habitat is city streets, and don't even think about beating that yellow light. You won't make it. With a full charge, we drove the Smart aggressively—and overestimated the range. We ran out of juice after 81.1 miles. The only fortunate part about a stranded Smart is that it weighs only 1958 pounds, so it's easy to push it to the nearest outlet—if you can find one. — *BEN STEWART*

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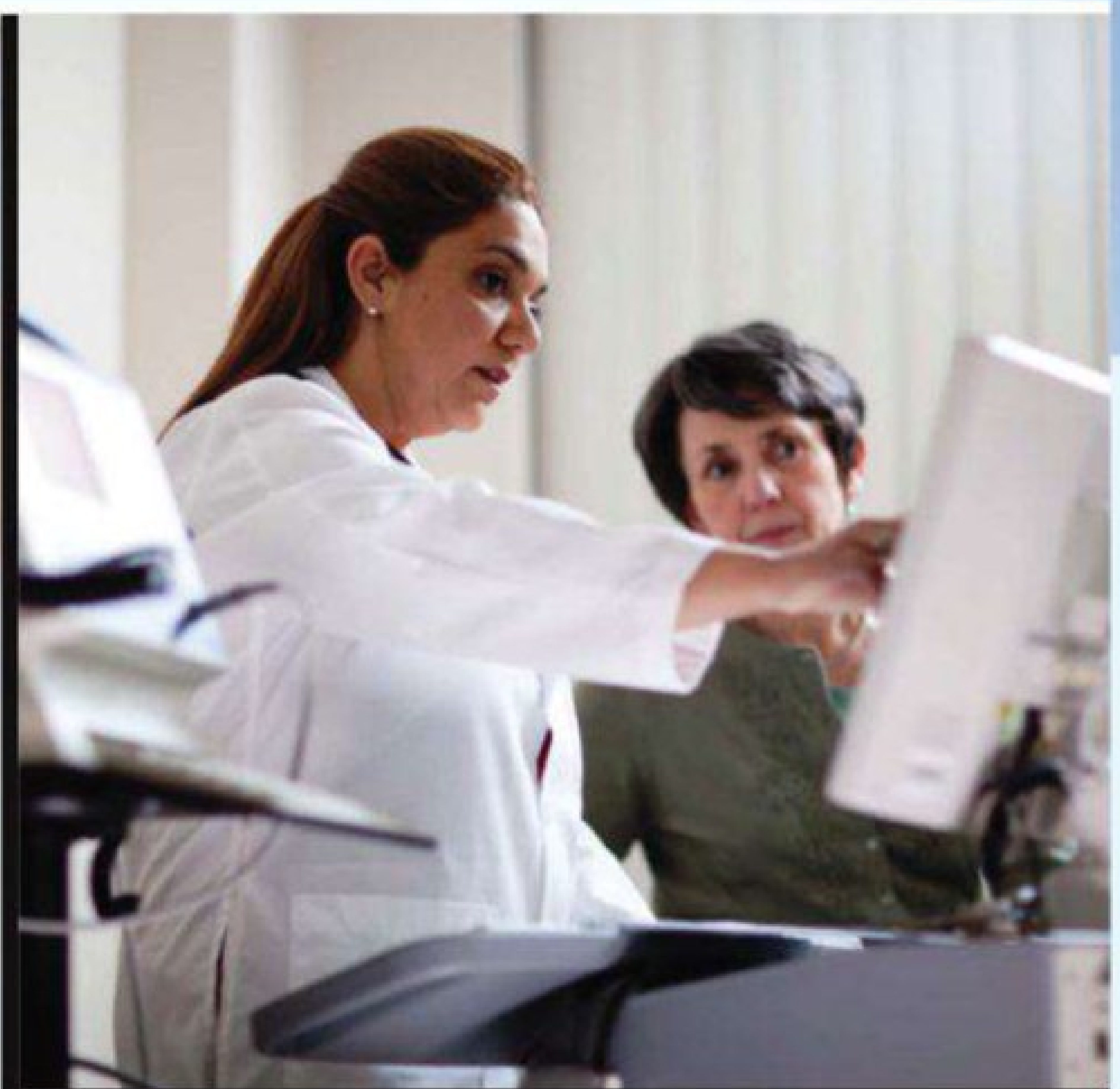


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If you have an irregular heartbeat called *atrial fibrillation*
not caused by a heart valve problem
ask your doctor about **PRADAXA**.

- In a clinical trial, PRADAXA 150 mg **reduced stroke risk 35% more** than warfarin.
Risk reduction was greatest when compared to patients on warfarin
whose blood tests showed lower levels of control.
- **No regular blood tests**

PRADAXA is a prescription blood-thinning medicine used to reduce the risk of stroke and blood clots in people with atrial fibrillation not caused by a heart valve problem. With atrial fibrillation, part of the heart does not beat the way it should. This can cause blood clots to form, increasing your risk of a stroke. PRADAXA lowers the chance of blood clots forming in your body.

IMPORTANT SAFETY INFORMATION ABOUT PRADAXA

PRADAXA can cause bleeding which can be serious and sometimes lead to death. Don't take PRADAXA if you currently have abnormal bleeding or if you have ever had an allergic reaction to it. **Your risk of bleeding with PRADAXA may be higher if you:** are 75 years old or older, have kidney problems, have stomach or intestine bleeding that is recent or keeps coming back or you have a stomach ulcer, take other medicines that increase your risk of bleeding, like aspirin products, non-steroidal anti-inflammatory drugs (NSAIDs) and blood thinners.

Call your doctor or seek immediate medical care if you have any of the following signs or symptoms of bleeding: any unexpected, severe, or uncontrollable bleeding; or bleeding that lasts a long time, unusual or unexpected bruising,

coughing up or vomiting blood; or vomit that looks like coffee grounds, pink or brown urine; red or black stools (looks like tar), unexpected pain, swelling, or joint pain, headaches and feeling dizzy or weak.

It is important to tell your doctor about all medicines, vitamins and supplements you take. Some of your other medicines may affect the way PRADAXA works.

Take PRADAXA exactly as prescribed by your doctor. Don't stop taking PRADAXA without talking to your doctor as your risk of stroke may increase.

Tell your doctor if you are planning to have **any** surgery, or medical or dental procedure, because you may have to stop taking PRADAXA for a short time. PRADAXA can cause indigestion, stomach upset or burning, and stomach pain.

You are encouraged to report negative side effects of prescription drugs to the FDA.

Visit www.fda/medwatch or call 1-800-FDA-1088.

Please see more detailed Medication Guide on next page.

Reduce your risk of a stroke caused by a clot that starts in the heart.

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Read this Medication Guide before you start taking PRADAXA and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking with your doctor about your medical condition or your treatment.

What is the most important information I should know about PRADAXA?

- PRADAXA can cause bleeding which can be serious, and sometimes lead to death. This is because PRADAXA is a blood thinner medicine that lowers the chance of blood clots forming in your body.
- **You may have a higher risk of bleeding if you take PRADAXA and:**
 - Are over 75 years old
 - Have kidney problems
 - Have stomach or intestine bleeding that is recent or keeps coming back, or you have a stomach ulcer
 - Take other medicines that increase your risk of bleeding, including:
 - aspirin or aspirin containing products
 - long-term (chronic) use of non-steroidal anti-inflammatory drugs (NSAIDs)
 - warfarin sodium (Coumadin[®], Jantoven[®])
 - a medicine that contains heparin
 - clopidogrel (Plavix[®])
 - prasugrel (Effient[®])

Tell your doctor if you take any of these medicines. Ask your doctor or pharmacist if you are not sure if your medicine is one listed above.

- PRADAXA can increase your risk of bleeding because it lessens the ability of your blood to clot. While you take PRADAXA:
 - You may bruise more easily
 - It may take longer for any bleeding to stop

Call your doctor or get medical help right away if you have any of these signs or symptoms of bleeding:

- Unexpected bleeding or bleeding that lasts a long time, such as:
 - unusual bleeding from the gums
 - nose bleeds that happen often
 - menstrual bleeding or vaginal bleeding that is heavier than normal
- Bleeding that is severe or you cannot control
- Pink or brown urine
- Red or black stools (looks like tar)
- Bruises that happen without a known cause or get larger
- Cough up blood or blood clots
- Vomit blood or your vomit looks like "coffee grounds"
- Unexpected pain, swelling, or joint pain
- Headaches, feeling dizzy or weak

Take PRADAXA exactly as prescribed. Do not stop taking PRADAXA without first talking to the doctor who prescribes it for you. Stopping PRADAXA may increase your risk of a stroke.

PRADAXA may need to be stopped, if possible, for one or more days before any surgery, or medical or dental procedure. If you need to stop taking PRADAXA for **any reason**, talk to the doctor who prescribed PRADAXA for you to find out when you should stop taking it. Your doctor will tell you when to start taking PRADAXA again after your surgery or procedure.

See "What are the possible side effects of PRADAXA?" for more information about side effects.

What is PRADAXA?

PRADAXA is a prescription medicine used to reduce the risk of stroke and blood clots in people who have a medical condition called atrial fibrillation. With atrial fibrillation, part of the heart does not beat the way it should. This can lead to blood clots forming and increase your risk of a stroke. PRADAXA is a blood thinner medicine that lowers the chance of blood clots forming in your body.

It is not known if PRADAXA is safe and works in children.

Who should not take PRADAXA?

Do not take PRADAXA if you:

- Currently have certain types of abnormal bleeding. Talk to your doctor, before taking PRADAXA if you currently have unusual bleeding.
- Have had a serious allergic reaction to PRADAXA. Ask your doctor if you are not sure.

What should I tell my doctor before taking PRADAXA?

Before you take PRADAXA, tell your doctor if you:

- Have kidney problems
- Have ever had bleeding problems
- Have ever had stomach ulcers
- Have any other medical condition
- Are pregnant or plan to become pregnant. It is not known if PRADAXA will harm your unborn baby.
- Are breastfeeding or plan to breastfeed. It is not known if PRADAXA passes into your breast milk.

Tell all of your doctors and dentists that you are taking PRADAXA. They should talk to the doctor who prescribed PRADAXA for you, before you have **any** surgery, or medical or dental procedure.

Tell your doctor about all the medicines you take, including prescription and non-prescription medicines, vitamins, and herbal supplements. Some of your other medicines may affect the way PRADAXA works. Certain medicines may increase your risk of bleeding. See "What is the most important information I should know about PRADAXA?"

Especially tell your doctor if you take:

- rifampin (Rifater, Rifamate, Rimactane, Rifadin)

Know the medicines you take. Keep a list of them and show it to your doctor and pharmacist when you get a new medicine.

How should I take PRADAXA?

- **Take PRADAXA exactly as prescribed by your doctor.**
- Do not take PRADAXA more often than your doctor tells you to.
- You can take PRADAXA with or without food.
- Swallow PRADAXA capsules whole. Do not break, chew, or empty the pellets from the capsule.
- If you miss a dose of PRADAXA, take it as soon as you remember. If your next dose is less than 6 hours away, skip the missed dose. Do not take two doses of PRADAXA at the same time.
- Your doctor will decide how long you should take PRADAXA. **Do not stop taking PRADAXA without first talking with your doctor. Stopping PRADAXA may increase your risk of stroke.**
- Do not run out of PRADAXA. Refill your prescription before you run out. If you plan to have surgery, or a medical or a dental procedure, tell your doctor and dentist that you are taking PRADAXA. You may have to stop taking PRADAXA for a short time. See "What is the most important information I should know about PRADAXA?"
- If you take too much PRADAXA, go to the nearest hospital emergency room or call your doctor or the Poison Control Center right away.

What are the possible side effects of PRADAXA?

PRADAXA can cause serious side effects.

- See "What is the most important information I should know about PRADAXA?"
- Allergic Reactions. In some people, PRADAXA can cause symptoms of an allergic reaction, including hives, rash, and itching. Tell your doctor or get medical help right away if you get any of the following symptoms of a serious allergic reaction with PRADAXA:
 - chest pain or chest tightness
 - swelling of your face or tongue
 - trouble breathing or wheezing
 - feeling dizzy or faint

Common side effects of PRADAXA include:

- indigestion, upset stomach, or burning
- stomach pain

Tell your doctor if you have any side effect that bothers you or that does not go away.

These are not all of the possible side effects of PRADAXA. For more information, ask your doctor or pharmacist.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store PRADAXA?

- Store PRADAXA at room temperature between 59°F to 86°F (15°C to 30°C). After opening the bottle, use PRADAXA within 30 days. Safely throw away any unused PRADAXA after 30 days.
- Store PRADAXA in the original package to keep it dry. Keep the bottle tightly closed.

Keep PRADAXA and all medicines out of the reach of children.

General information about PRADAXA

Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. Do not use PRADAXA for a condition for which it was not prescribed. Do not give your PRADAXA to other people, even if they have the same symptoms. It may harm them.

This Medication Guide summarizes the most important information about PRADAXA. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about PRADAXA that is written for health professionals.

For more information, go to www.PRADAXA.com or call 1-800-542-6257 or (TTY) 1-800-459-9906.

What are the ingredients in PRADAXA?

Active ingredient: dabigatran etexilate mesylate

Inactive ingredients: acacia, dimethicone, hypromellose, hydroxypropyl cellulose, talc, and tartaric acid. The capsule shell is composed of carrageenan, FD&C Blue No. 2, FD&C Yellow No. 6, hypromellose, potassium chloride, titanium dioxide, and black edible ink.

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Issued March 2011

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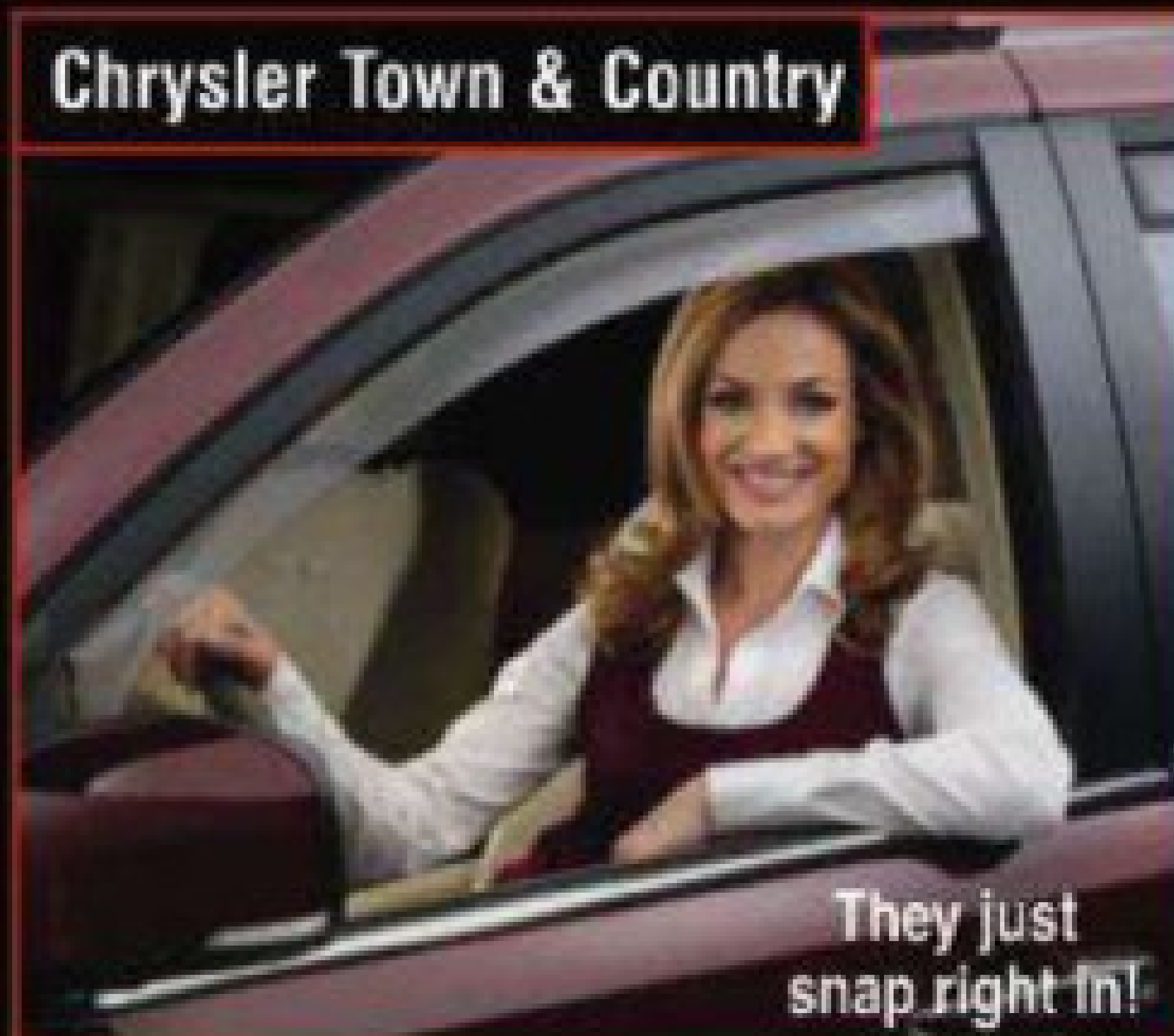


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Off-Roaders for Connoisseurs

For those who aren't interested in factory-made trail rigs, two companies offer specialty mudslingers that make getting dirty an art form. *BY LARRY WEBSTER*

Perfected FJ

More reboot than restoration, Icon's latest take on Toyota's rugged FJ40 Land Cruiser is a prime example of founder Jonathan Ward's obsession with perfection. The newest model, the FJ44 is what you'd get if Land Rover had continued developing the FJ40 after Toyota pulled up stakes in 1984. Every aspect has been improved, from the thick, box-section frame, to the GM 5.7-liter V8, to the meticulous interior details (machined aluminum knobs and even heated seats) and a body stamped from aluminum so it won't rust. It drives more precisely than its utilitarian design suggests, thanks to four-link coil-spring suspension, and the thick cloth top does an admirable job of quelling road noise. Forget the creature comforts, the mechanical click of the gearshift, and the woven Chilewich carpet and you're left with a beastly off-roader. The Atlas transfer case and ARB locking diffs permit manual control of torque distribution, and there are tractor-like approach and departure angles. Who's game for a road trip up Mount Kilimanjaro? We can only hope the affluent buyers (it starts at \$150,000) won't be shy about soiling this off-road tribute.

2011
Icon FJ44

WHERE TO
TEST
YOUR RIG'S
METTLE

OCOTILLO WELLS SVRA
BORREGO SPRINGS, CALIF.

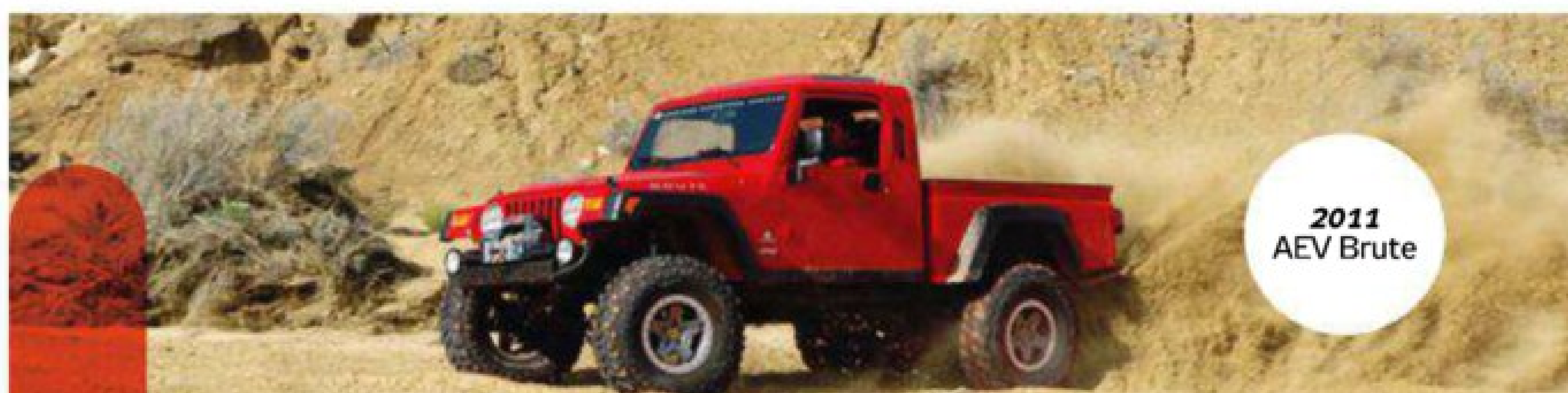
A huge, 80,000-acre desert playground located northeast of San Diego. For a real challenge, try to ascend Devil's Slide, a 200-foot-tall steep and sandy hill that's littered with abandoned mineshafts.

SOUTHERN MISSOURI OFF ROAD
RANCH, SEYMOUR, MO.

Rock ledges, water crossings and, most of all, muddy holes challenge the toughest four-wheelers. It costs only \$20 a day, and if your significant other tires of bouncing around, there are horse trails too.

RAUSCH CREEK OFF ROAD PARK,
TREMONT, PA.

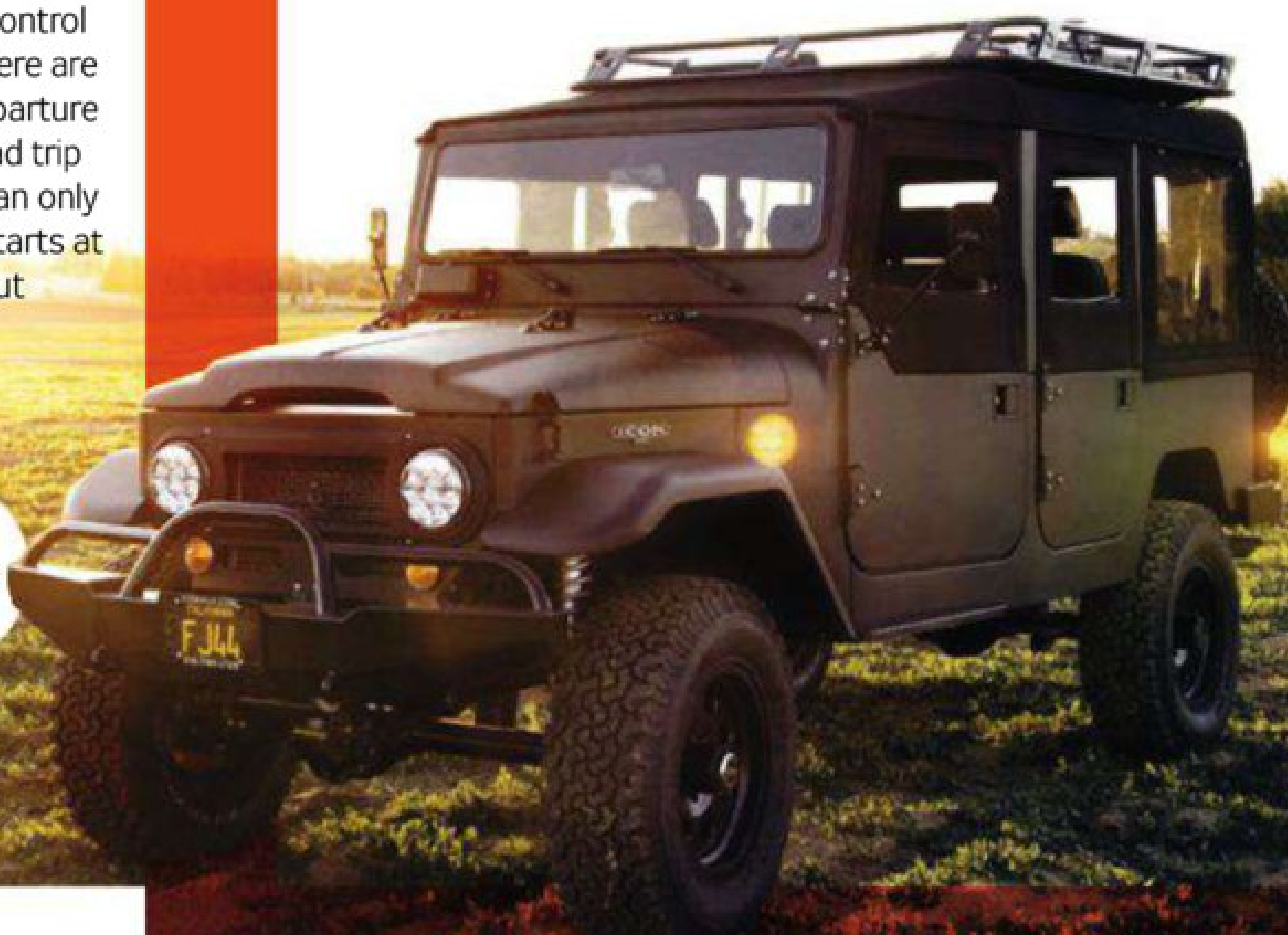
Located in the heart of Pennsylvania coal country and just 150 miles from the Big Apple, this 3000-acre private enclave has everything from boulder fields to wooded trails. It's open all year, and a day pass costs \$35.



2011
AEV Brute

The Missing Link

There hasn't been a pickup version of Jeep's down-and-dirty off-roader since the Scrambler of the early '80s. But there is a way to build your own with an \$8995 kit from the aftermarket company American Expedition Vehicles (AEV). This is not, however, one of those weekend projects that you can knock off with the help of a few friends and free beer. Not only does the body have to be separated from the frame, it needs to be cut in half so the supplied rear body can be welded on. A removable fiberglass top completes the cab. In addition, the frame has to be stretched 2 feet by cutting it at the midsection and welding in the included stringers. AEV says the process takes about 60 hours. But the finished product looks factory-made, and the 6-foot bed is constructed from heavy-gauge steel—stamped in Detroit, which somehow amps up the manly factor. From inside the Brute's cab, the cacophony of whistling wind and humming tires was a bit deafening, which is just like the standard Jeep the kit is made for: the 1997 to 2006 TJ Series Wrangler. AEV has numerous other body and chassis enhancements that can do serious credit card damage. If you're DIY-averse, you can always ship your Wrangler to Michigan and have AEV do the work.



BE ONE WITH IT

ventus V12 evo



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Simpler Sticker

Starting with the 2013 model year, all passenger vehicles will have the EPA's new window sticker with better metrics and provisions for alternative-fuel cars, plug-in hybrids and EVs.

- Now the EPA's combined fuel-economy number, which is a weighted average of the city and highway numbers, gets top billing. This is the figure typical drivers will hit most of the time.
- Finally: fuel consumption expressed in gallons per 100 miles. This number makes it easier to compare the efficiency of different cars.
- To get a perfect 10 on this scale, the car has to return better than 38 mpg.



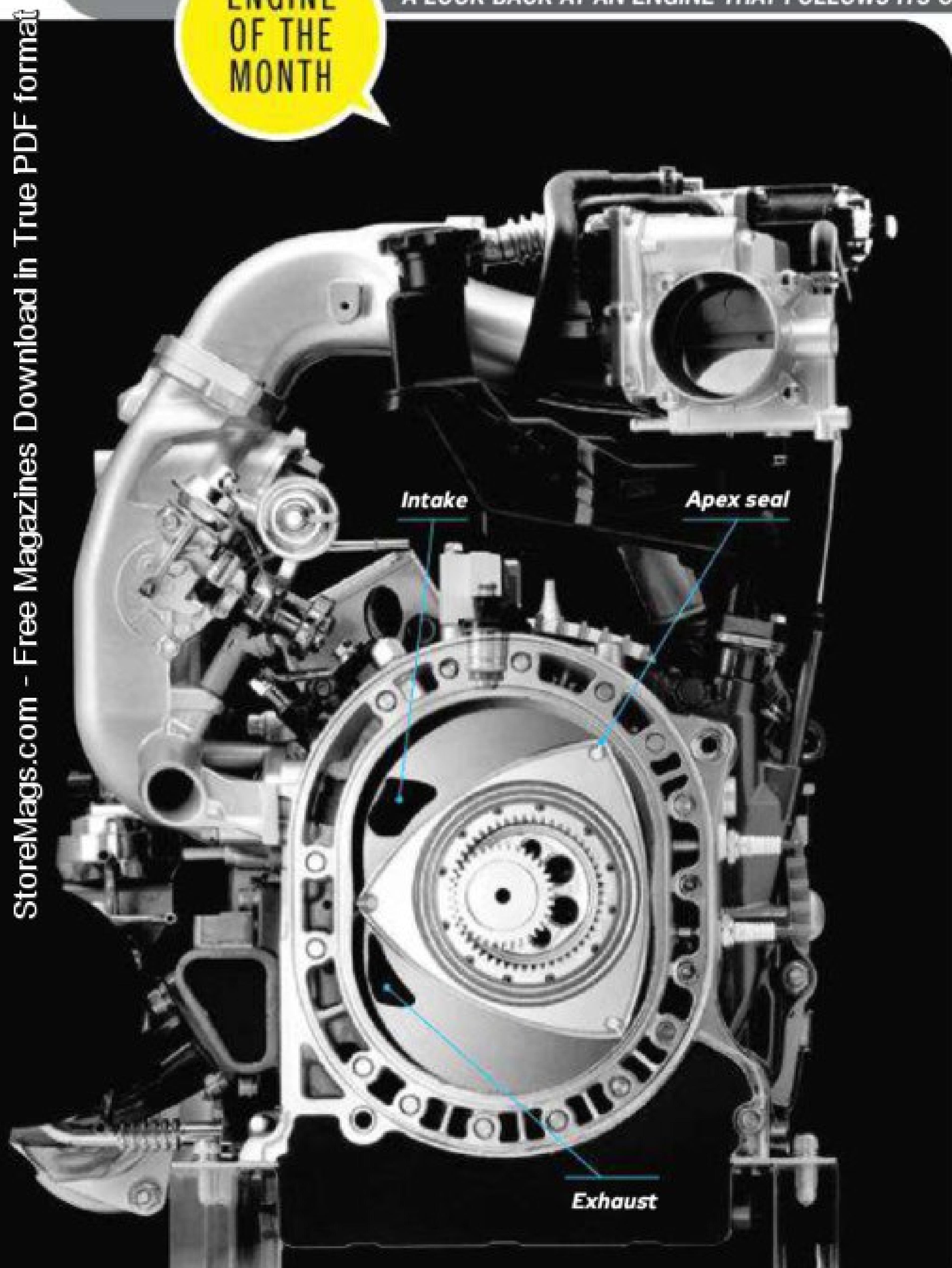
Savings are based on the "average" vehicle, which in the EPA's world gets 22 combined mpg and requires \$12,600 worth of fuel over five years.

"Smog" includes everything—except CO₂—that exits the exhaust pipe. Only EVs score a 10.

Scan this tablet with a smartphone to quickly compare other cars and calculate personal estimated fuel costs.

ENGINE OF THE MONTH

A LOOK BACK AT AN ENGINE THAT FOLLOWS ITS OWN PATH

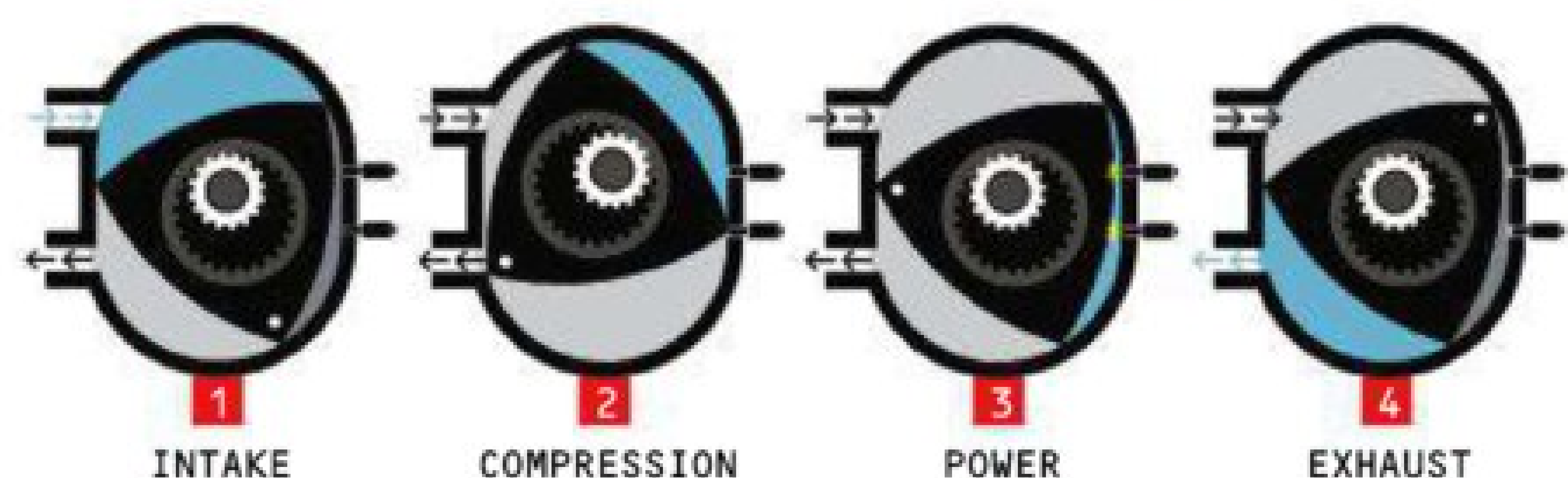


Mazda Rotary

HOW IT WORKS // Mazda's sweet-handling RX-8 won't return for 2012, and with it goes—for now—the unique Wankel rotary engine. It was patented in 1929 by Felix Wankel and licensed and developed by many companies, but only Mazda stuck with the engine. It's an elegantly simple design: A three-lobed rotor rotates inside a peanut-shaped (the technical term is epitrochoid) housing. The four engine "strokes"—intake, compression, power and exhaust—occur between the rotor's outer edge and the housing. There are no valves, as the gases enter and exit through ports in the housing. Rotaries are naturally smooth since there's no reciprocating motion as in a piston engine, just a buttery flow of power as they climb the rev range. They're about one-third smaller than a conventional engine of similar power, and modular. If you want more power, it's relatively easy to add another rotor and housing (the RX-8 uses two rotors, but Mazda's 1991 Le Mans-winning race car used four). What's the downside? The seals at the rotor apex aren't as robust as piston rings, so these engines are challenged to meet high-mileage emissions requirements. And they tend to be thirsty. Mazda says the rotary will return, and we hope that's true. Running an RX-8 through the gears is an experience that's not soon forgotten.

— LARRY WEBSTER

THE WANKEL ROTARY IN DETAIL



ILLUSTRATIONS BY DOGO



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Long-Term Test Cars

OUR EV EXPERIENCE COMES TO A CLOSE AND HYUNDAI'S SONATA CLEARS 20,000 MILES IN A YEAR.



2011 Nissan Leaf SL

FINAL report

Press the power button on the Nissan Leaf and the vehicle burbles a quick series of chiming tones. It's the sort of musical motif a high-end laptop might emit, or perhaps what Steve Jobs's doorbell sounds like. That musical welcome is a fitting introduction to a car that is more gleaming gadget than traditional automobile.

There are plenty of vehicles for drivers who want great mileage; the Leaf is not for them. This car is for

the radical early adopter, the driver who wants to make a total break from liquid fuels.

To test the car, we had a 240-volt EV charging station installed at our office, and used the much slower 120-volt charging option at various editors' homes. Over the nearly three months we drove the Leaf, we learned a lot about what it means to live with a pure electric vehicle. The first thing most people notice is the silence—and the second is the instant torque. That combination is endlessly entertaining. The car

DRIVERS NOTEBOOK

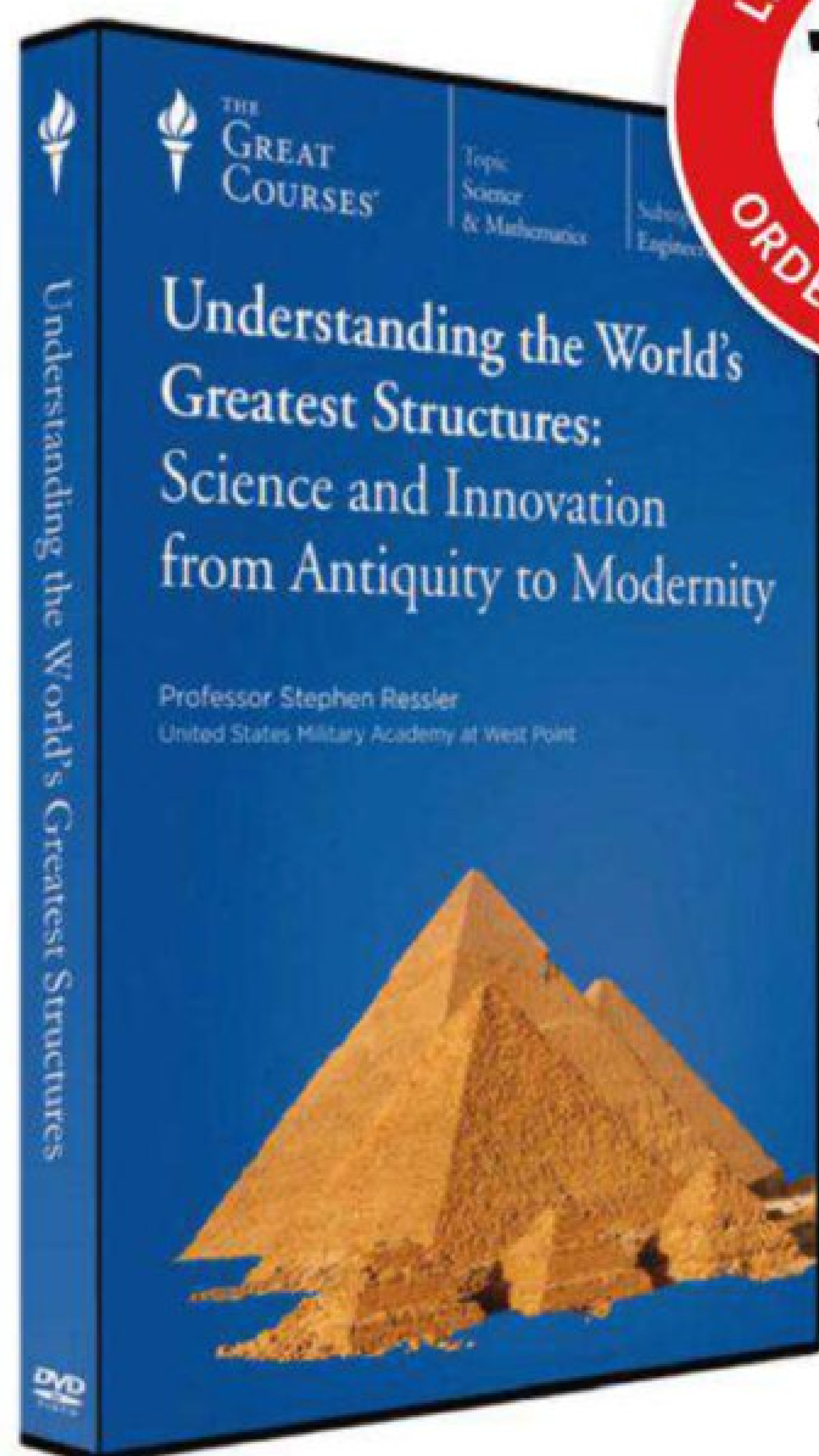
- The Leaf's integration of mechanical and regenerative braking is the best we've experienced.
- Even at New York's high electricity rates, the Leaf cost us less than 6 cents a mile to drive.

END DATA

As tested: \$28,165 (after subtracting the \$7500 federal tax rebate)
Previous report:

See 06/11
Miles driven: 1641
Efficiency: Average—3.5 mi/kwh

Worst—2.7 mi/kwh
Best—5.3 mi/kwh
Maintenance/repair since last report: \$0
Overall: \$0



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seems to move effortlessly, almost like it's coasting. But floor the accelerator and the Leaf surges forward as if Scotty just tripped the warp drive.

And that's about when your eyes flick back to the range indicator. Did we mention the range indicator? No driver of a Leaf will forget it for long. This indicator is much more than a simple readout of how much juice is left in the 24-kilowatt-hour battery pack. It constantly analyzes your driving style and the conditions and calculates your range based on those factors. In our tests, the indicator usually read between 80 and 90 miles when we set out on a full charge. But pop off a couple of blistering starts and the Leaf would quickly cut the range estimate to 60 miles or less, sometimes much less.

Chilly out? Turn on the heat—and watch your range drop by another 10 to 15 miles. Even climbing the half-mile hill to one editor's home knocked 8 miles off the range. But the opposite is also true: Drive back down that hill and you can watch your range magically climb. Stuck in traffic? Great! The Leaf loves poking along at a hyperefficient 20 mph. On one slow commute we watched our range climb from 86 at the start to 96—after we'd driven 17 miles.

The Leaf's useful display offers a variety of additional modes to monitor energy use, and we found ourselves becoming geekily obsessed with efficiency. The key metric is miles per kwh: Overall, we averaged 3.5 miles per kwh. Our worst trip was 2.7, and our best was 5.3—which translates to a theoretical range of 127 miles.

And therein lies the challenge of living with an EV: Because the range is so variable, it's pretty nerve-racking to drive anywhere more than 25 miles from home base. What if you get lost? And if you do run out of juice, as one editor did, you're stuck looking for a plug. (Our unlucky colleague was turned away at a gas station but found an open outlet at a Nissan dealer.)

We enjoyed our experiment in living like the Jetsons and hope to see progress on EVs continue. But the hard reality is that pure EVs—even one as beautifully engineered as the Leaf—require more thought and planning than a conventional car. That's not to deny that EVs have their place, but for now, they really only make sense as a second, or even a third, car. — JIM MEIGS



DRIVERS NOTEBOOK

- While the Jeep's navigation system has been generally panned, at least it does display the speed limit, a helpful tool since this

SUV masks speed like a Mercedes.

- Enlarging the cargo area couldn't be easier—the rear headrests automatically flop forward when you fold the rear seat.

DATA SO FAR

As tested:

\$45,480

Previous report:

See 06/11

Miles driven:

4365

Miles since last

report: 4365

Fuel economy:

Average—18.3

mpg

Worst—13.8 mpg

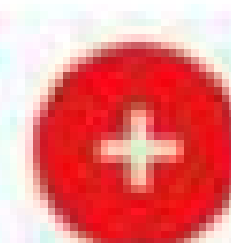
Best—23.2 mpg

Maintenance/

repair since last

report: \$31

Overall: \$31



2011 Jeep Grand Cherokee Overland

SECOND report

We departed for Maryland's Eastern Shore for a weekend of bicycling with three sprightly two-wheelers perched on a trailer. Why not on the roof? On our top-of-the-line Overland model, a hitch is standard, but crossbars for the roof rack are a \$220 dealer accessory. It was our fault for not ordering the bars in time, but we have to wonder: Why aren't they standard on a \$45,000 SUV? Yes, that's a small oversight, but the Grand is generally so polished and capable that we're left pointing out little details that Jeep didn't quite nail. High on that short list is the navigation system, which uses a small, 6.5-inch screen and Atari-like graphics. Compared to the rich interior materials, it looks and functions like a truck-stop add-on. On the positive side, no one fought for shotgun since the coddling rear seats feature individual seat heaters, a DVD system and reclining backrests. Plus, there's a 110-volt outlet rated for 20 amps, plenty to power a laptop if the desire to work emerges (it didn't). After 600 miles, we arrived so fresh and relaxed that we got in a quick 20-mile pedal before nightfall. — LARRY WEBSTER

PHOTOGRAPH BY MICHAEL NEMETH



Mazda2 Touring

THIRD report

DRIVERS NOTEBOOK

The Mazda2's minimalism contributes to the car's charm, but it can go too far. For instance, the cabin has no hook for hanging a coat or

dry cleaning. The relatively large windows, as well as the design and positioning of the pillars, make for excellent visibility—and a feeling of safety—while driving.

DATA SO FAR

As tested:

\$17,275

Previous reports:

See 03/11, 06/11

Miles driven:

9610

Miles since last

report: 2997

Fuel economy:

Average—32.0

mpg

Worst—27.2 mpg

Best—43.6 mpg

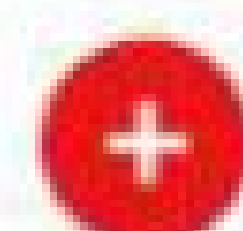
Maintenance/

repair since last

report: \$0

Overall: \$0

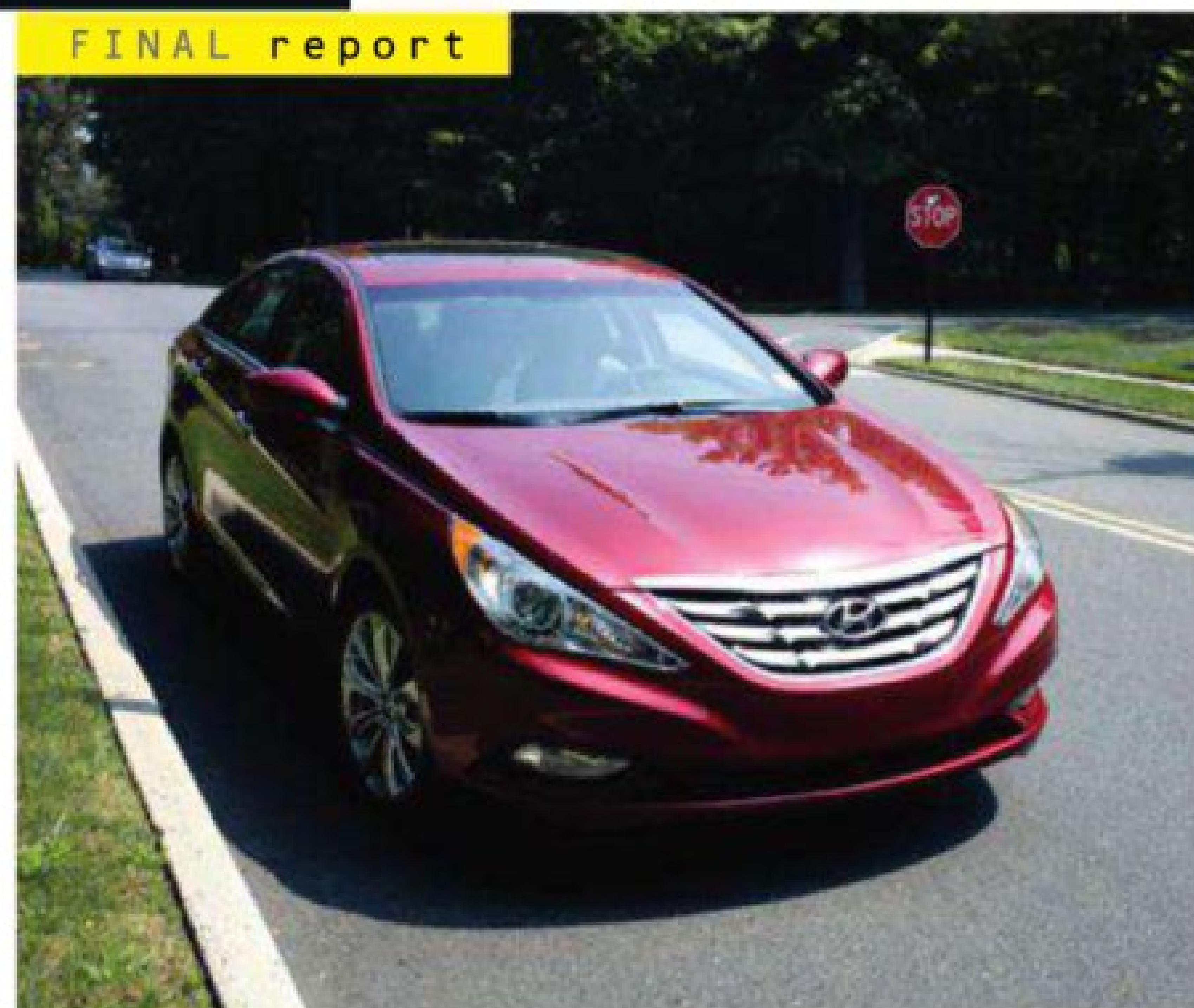
The old saw about using the right tool for the job also applies to automotive choices. For example, the modestly powered Mazda2—a great short-range commuter car—did not turn out to be the ideal vehicle for a 400-mile round trip from New York to Cambridge, Mass., for two adults and Muddy and Link, standard poodles of 82 and 53 pounds, respectively. We dubbed the Mazda “the lawnmower” for the high-decibel whine of the engine as the car struggled to haul the human and canine cargo up hills on the Mass Pike. The fuel economy dipped because we were in high-rev mode for much of the trip, and the Mazda seemed sensitive to crosswinds. But with the rear seats folded down to accommodate the dogs, the cabin was commodious for two- and four-legged beings alike. Indeed, the Mazda continues its reign as a PM staff favorite. One editor says, “It’s a comfy ride—fun to drive and very spacious,” and another commends the car as “nimble” and “great for street parking.” — JOE BARGMANN



Hyundai Sonata SE

The Sonata crested 20,000 miles in a single year of driving—a testament to its enduring appeal as the PM staff took it up and down the East Coast, from Maine to Georgia. With an infinitely adjustable driver's seat, intuitive controls, a sharp navigation program and a stout sound system, the car readily accommodated any driver with an urge to bang out 500 or more miles in a day. This sedan isn't a luxury car, but it's well-appointed and refined, and it offers remarkable value. After an excursion, many drivers would ask why anyone would spend more than 25 grand—the Sonata's price—for a car. The Sonata undercuts the established players like the Accord and the Camry, yet we found no evidence of low quality. The interior materials revealed little evidence of wear and tear, and nothing went wrong. We visited the dealer for routine service only, stopping twice, for a grand total of \$71. Plus, the Sonata regularly returned over 30 mpg when driven on the highway, quite a feat for a car so spacious. We'd happily go another 20,000 miles. — HARRY SAWYERS

FINAL report



DRIVERS NOTEBOOK

- One editor's parents, long-legged Southerners in their 60s, praised the back seat's ample legroom.
- The generous interior dimensions are contained in a tidy exterior, so the Sonata is still easy to park—even in New York City.

END DATA

As tested: \$25,330

Previous reports:

See 12/10, 03/11, 06/11

Miles driven:

21,239

Miles since last

report: 6439

Fuel economy:

Average—26.5 mpg

Worst—22.8 mpg

Best—34.8 mpg

Maintenance/

repair since last

report: \$38

Overall: \$71

Me and My Shadow

> BY JAY LENO
> PHOTOGRAPHS BY JOHN LAMM

M

MORE THAN A HALF-CENTURY after the last bike left the factory in Stevenage, England, people still praise the Vincent Black Shadow. It was the fastest motorcycle of its era, widely considered the world's first superbike, and it still holds its own on the highway. You've probably seen that famous 1948 photo of American motorcyclist Rollie Free wearing just a bathing suit, a rubber cap and sneakers while setting a 150-mph record on a modified Shadow at the Bonneville Salt Flats (bottom, far left). The image was flashed around the world.

Where I grew up, in a small New England town, the Vincent was a motorcycle you only ever heard about. But the legend surrounding

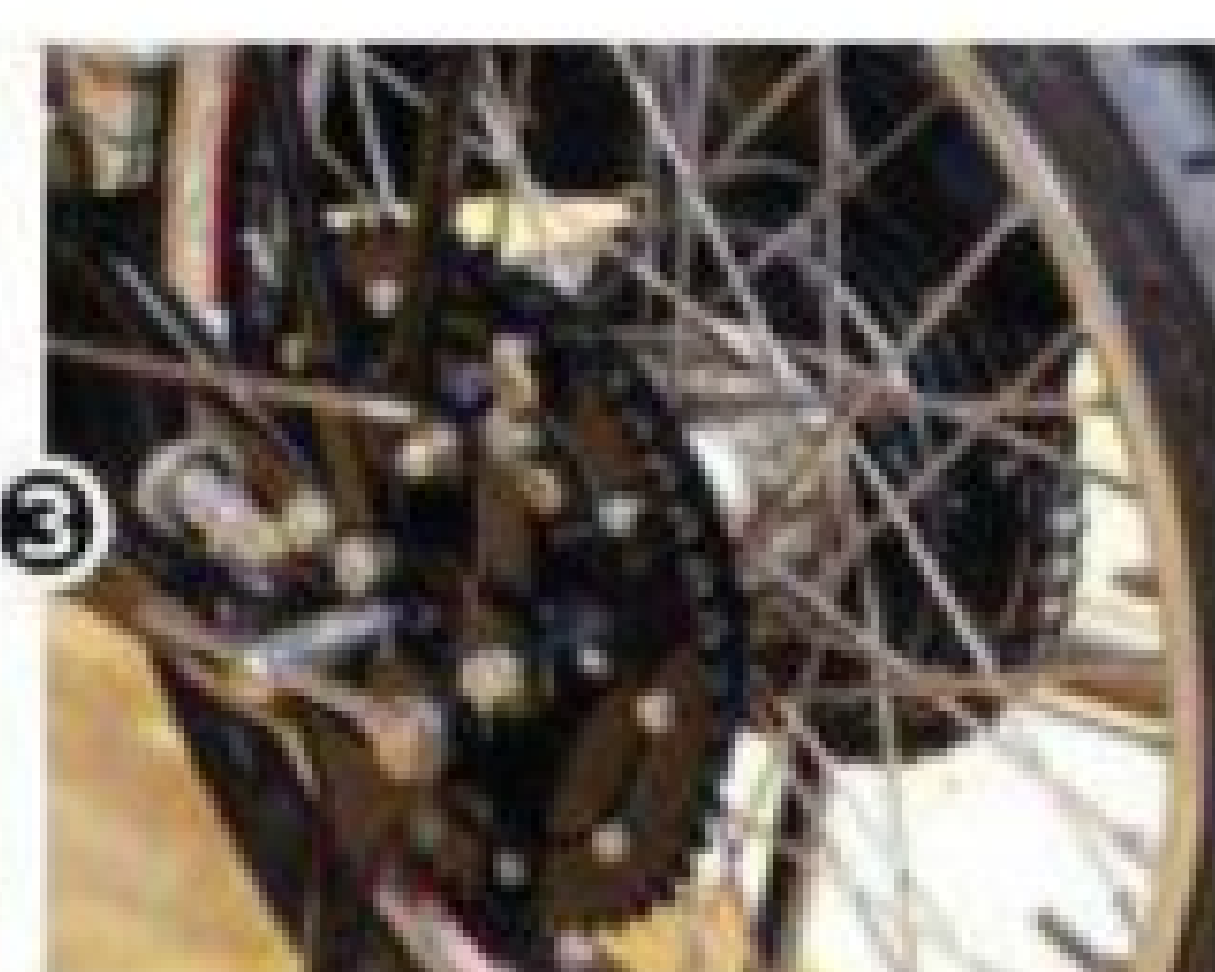
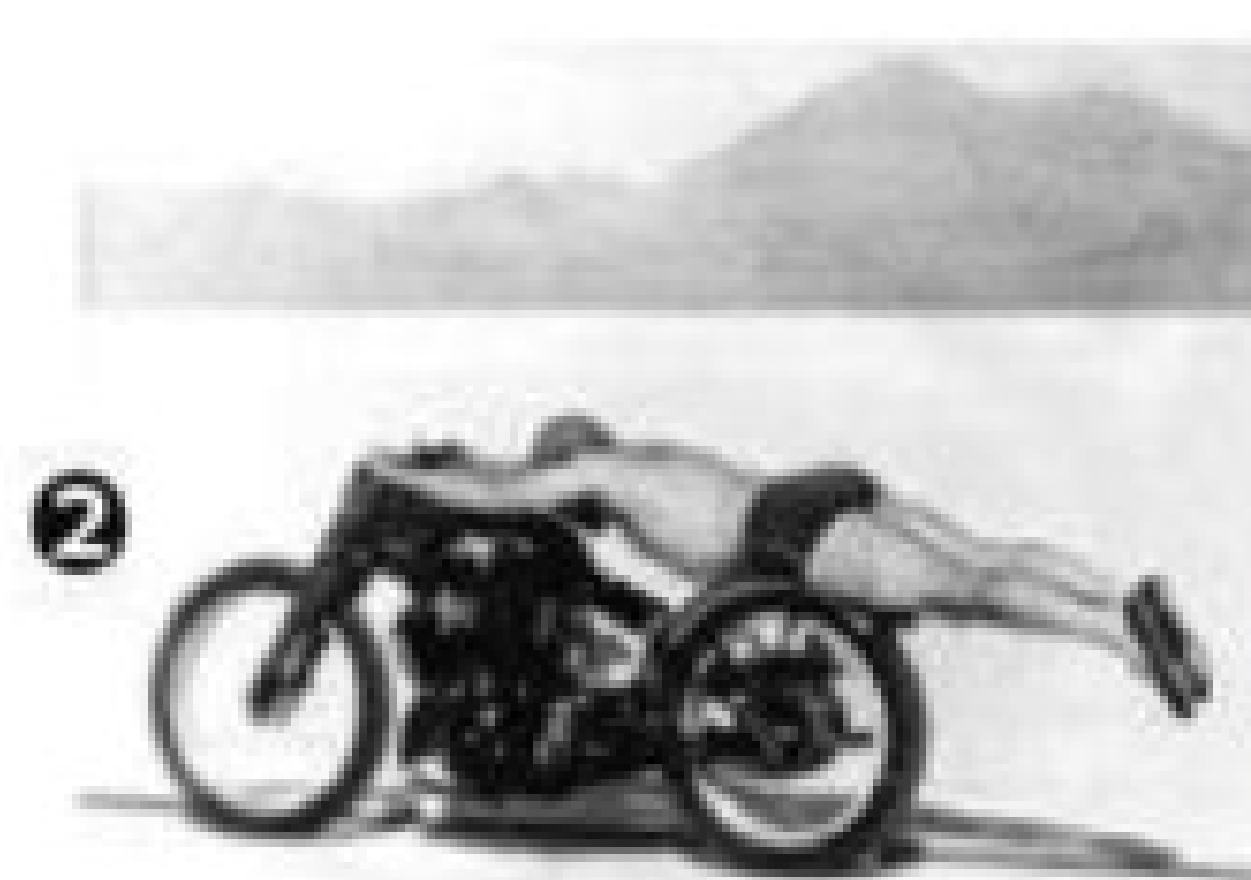
THE FASTEST BIKE OF ITS ERA, THE VINCENT BLACK SHADOW IS JAY'S FAVORITE MOTORCYCLE.

the bike was so strong. There was a guy who lived a couple of towns over who had a Vincent that had allegedly run in the renowned Isle of Man Tourist Trophy race off the coast of the U.K. Every now and then, somebody at school would say, "I heard it go by the other night." All the kids would stop to listen to his story. "What did it look like? What did it sound like?" We all wanted to know.

I only saw that bike once, when I was in high school. Thirty years later, I heard about a Vincent for sale in Haverhill, Mass. I tracked it down and discovered it was the same one. Now it's sitting in my garage. Turns out, it was a Series C Black Shadow, and "Big Sid" Biberman, a famous Vincent mechanic, had rebuilt the engine. It had a custom frame similar to a Norton Featherbed.

(1) Black engine, black crankcase, black body—hence, the Shadow. (2) Streamlined Rollie Free, en route to a record. (3) The rear hub includes two sprockets for easy gear adjustment. (4) A Smiths speedometer helps define the Shadow's signature look.

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The Series C Black Shadow is the most sought-after Vincent. Its 998-cc V-twin puts out 55 hp; the Black Lightning racing version is good for 70 hp. That may not seem like much, but a Vincent twin weighs just 458 pounds, about as much as a 500-cc single. A well-tuned Shadow could hit 125 mph in an era when doing an honest 100 mph—or “the ton,” as the British say—was impossible for many bikes.

People forget that in 1952, the fastest series production vehicles in the world came from England. The fastest saloon car was the Bentley Continental, the fastest sports car was the Jaguar XK120, and the fastest motorcycle was the Vincent Black Shadow. Vincent ads read: “The World’s Fastest Standard Motorcycle. This is a Fact Not a Slogan.”

Shadows are essentially blue-printed Vincent Rapides, with hotter cams, bigger carburetors, a higher compression ratio and a lower first gear for better acceleration. Their engines are stove-enamel black.

All Shadows have a prominent 5-inch chronometric speedometer that you can read a mile away. The needle doesn’t fly around; it advances—ink, ink, ink—in steady increments. Once when I was riding one of my Shadows, a cop pulled me over. “Y’know how fast you were goin’?” he asked.

“No, sir,” I replied. “I’ve no idea.”

“You were doin’ 93 miles an hour,” he said. “I clocked you right off your speedometer!”

Aside from being fast, Vincents are technically interesting. Their narrow-angle V-twins have aluminum pistons, forged connecting rods, a unique rocker arm design, twin Amal carburetors and a dry sump oiling system. There is no front downtube; the engine itself is a stressed member. Changing wheels requires only simple T-handles, or tommy bars, as the British call them. The rigid Girdraulic

front forks are easily adapted for sidecar work by flipping a cam over to change the setting, and there are two rear sprockets, quickly reversible, so you can run a sidecar with a lower gear ratio.

At a time when no other motorcycle manufacturer gave a hoot about brakes—American bikes had just one rear brake for years—Vincents had four brake drums, one on each side of the hub, each with a balance bar; Shadows had finned drums. Vincents also boasted four speeds when a Harley-Davidson had only three.



**MOTORCYCLES DON'T HAVE A
“GAIT” ANYMORE, BUT RIDING A
VINCENT IS A LITTLE LIKE RIDING
A THOROUGHBRED HORSE.**

The rarest of my 10 Vincents is a prewar Series A. They called it the plumber’s nightmare because it has so many external oil lines. In the owner’s manual, it actually says: “After every 1000 miles, disassemble the engine and check everything. Reassemble.” The Brits insist that there’s nothing more enjoyable than spending a Saturday morning decoking the head on a motorcycle. Not true. People like to ride their bikes.

Motorcycles don’t have a “gait” anymore, but riding a Vincent is a little like riding a thoroughbred horse. The engine fires about once every lamp-post. There’s a measurable heartbeat-like quality to the sound of the V-twin that doesn’t exist with a four-cylinder or a high-revving parallel twin.

You accelerate and the engine goes *DibdibdibdibDIBDIBDIBDIIIIIIIIIB!!!*

The riding position is the classic British “sit up and beg” stance. It’s comfortable, and everything is adjustable. If you have big feet, you can extend the shift lever so your toe catches the end of it. There’s also a hand shifter, so veterans who couldn’t fully use their legs could reach down and shift. Even the Feridax Dualseat, a first on a motorcycle, was adjustable. You could alter brake tension with your fingertips. It was a true enthusiast’s machine.

Sadly, that level of detail helps explain why the company ceased motorcycle production in 1955. There is a lot of time-consuming handwork involved in a Vincent. They say the best ones were made before 1951, because in later bikes, the dies tended to wear out in the stamping presses and the parts weren’t as good. They were also expensive bikes, costing about \$1200 when a Triumph twin was roughly \$600.

At the end, Vincent was trying to sell fully faired Black Knights and Black Princes. They had taken the most beautiful engine in motorcycling and covered

it up so the bike looked like a big Vespa. Although fully faired motorcycles caught on years later, the Vincents were so far ahead of their time that the 1956 film version of George Orwell’s novel *1984* had the police riding them.

You can tell that Vincents are my favorite motorcycles. There’s a wonderful mechanical-ness to them; they are such quality machines. When you check the oil in a Vincent primary case, there’s a beautiful aluminum knurled knob on the dipstick. It’s overdesigned, way better than it needs to be. The general public ignored this kind of detailing because they could buy something cheaper. But today, the Vincent is considered a piece of art to be revered.

PM

The Real Truth of 9/11

> JAMES B. MEIGS

O

N A CHILLY FALL EVENING IN 2006 I WAS CAUGHT UP in the surge of commuters heading toward New York's Grand Central Terminal when I spotted a stationary figure on the street corner. He was handing out leaflets, and I politely took one. The headline read, "9/11 Was an Inside Job."

For some reason I stopped. "You know," I told him, "there's a book you should read." I mentioned *Debunking 9/11 Myths: Why Conspiracy Theories Can't Stand Up to the Facts*, which POPULAR MECHANICS had published several months earlier. Oh, he knew all about the book, he assured me: "It's totally bogus."

But I pressed him: Had he actually read it? Well, no, he admitted, but his sources on the Internet all agreed with his view. Then he gave me a funny look. "Hey, I know who you are." This was not unexpected. POPU-

LAR MECHANICS had been investigating 9/11 conspiracy theories since late 2004, and our involvement in this issue had given me and other PM editors a very minor and unwelcome sort of celebrity. In both our book and in an earlier cover story, we looked seriously at the most prominent claims made by conspiracy theorists—for example, the assertion that the World Trade Center fires weren't hot enough to make the buildings collapse.

Conspiracy theorists often say they are "just asking questions." Many call themselves—without a hint of irony—"9/11 truthers." So when a leading science and technology magazine thoroughly investigated the questions they had raised, did they soberly consider our findings? Of course not. Conspiracy theorists turned on POPULAR MECHANICS with a vengeance. In their view, anyone who challenged their conclusions had to be part of the conspiracy. Their attacks ranged from amusing (our magazine had published this investigation on orders from a cabal of Masons and Illuminati) to alarming (death threats were referred to our security department).

The young man on the street corner no doubt honestly believed his own government had engineered the killing of nearly 3000 of his fellow citizens. And that he was now speaking to



the editor of a magazine that had helped cover up that crime. His pamphlet was crammed with supposed facts that supported his views. And yet he'd never bothered to read one of the few objective, in-depth investigations of those alleged facts. Like his fellow truthers, he wasn't actually interested in facts. He had

FOR 10 YEARS CONSPIRACY THEORISTS HAVE BEEN SPINNING FANTASIES ABOUT 9/11. POPULAR MECHANICS HAS PLAYED A KEY ROLE IN ESTABLISHING THE FACTS.

predetermined conclusions about who was responsible for 9/11 and rigorously avoided any information that might challenge his ideology.

But the facts surrounding Sept. 11, 2001, do matter. If there were even the slightest truth to the allegations of conspiracy theorists, those facts would be of the gravest geopolitical and historical importance.

And, just to be clear, in all the research POPULAR MECHANICS has done on this topic, we have not found a single case in which the conspiracy claims were true. We did find many cases in which theorists had twisted, misrepresented or flatly made up their "evidence."

I'm proud that POPULAR MECHANICS has played such a prominent role in challenging these widespread falsehoods. A new, updated edition of *Debunking 9/11 Myths* comes out this month. I hope it is the last time we have to tackle this highly charged topic.

The corner where the young truther and I chatted that evening was only a block from the spot on Fifth Avenue where, on a crystal-clear morning in 2001, I watched flames pouring out of the World Trade Center's South Tower. The facts of Sept. 11 matter. We owe it to the victims of that day to remember them clearly. **PM**

To purchase the new edition, visit bn.com/debunking.

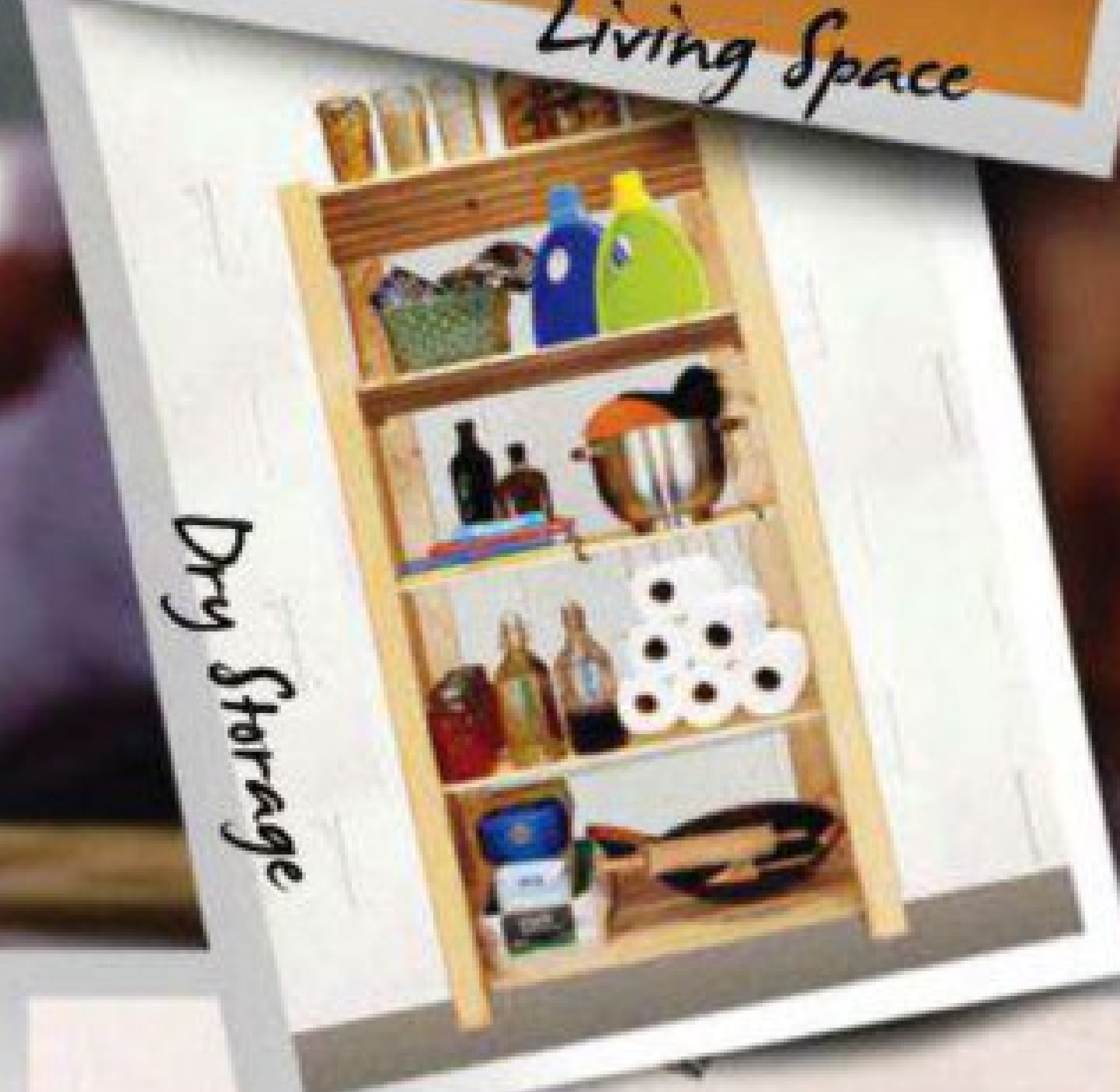
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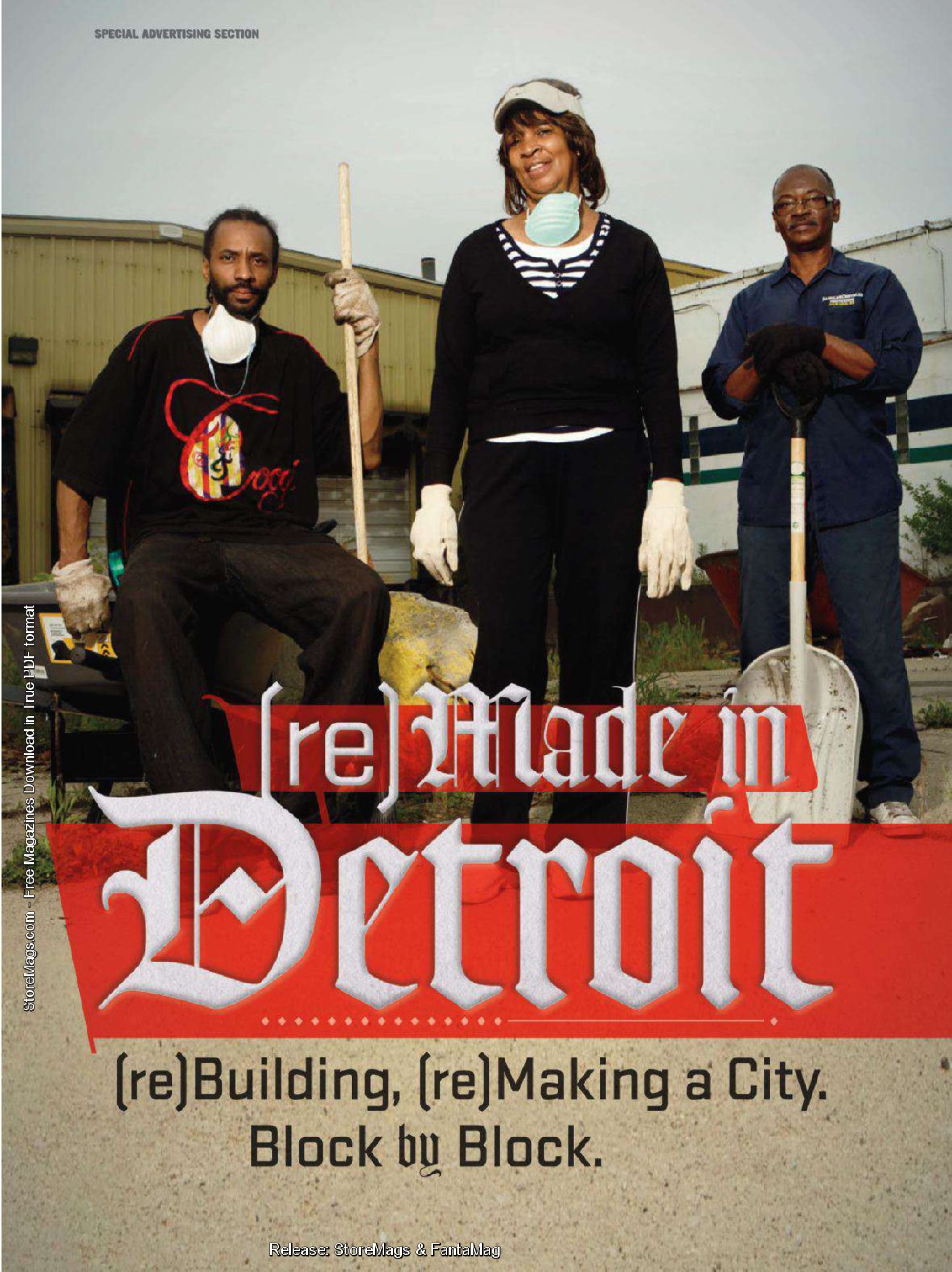
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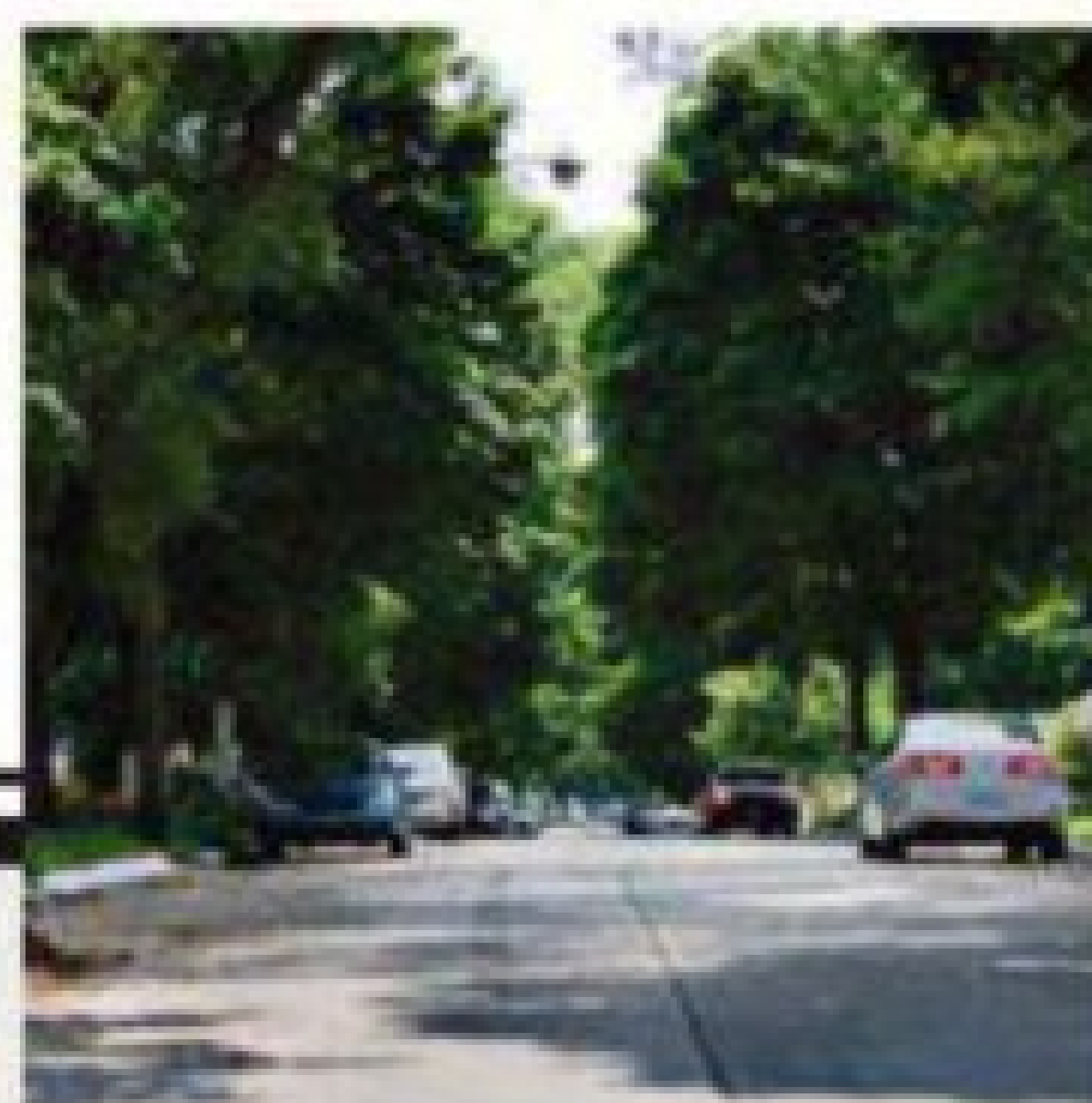
Citizens of Detroit know their town is down. They don't need anyone to tell them.

They live it. They see it every day when they step out of their doors in the morning. They hear it when they turn on their TVs in the evening. The rest of America knows it, too. They see it on TV as well— "Detroit in Decay." "Down in The 'D'." You know the story.

They know what their city needs: a revival of the spirit and energy that once upon a time made Detroit a beacon of industrial might. One weekend in June, we loaded supplies into a beautiful and highly efficient 2011 RAM® Power Wagon Crew Cab and headed over to Ethel street. We found signs of a potential revival under way.

But not the whole story.

People still live in Detroit—people like those on Ethel Street in the Southwest section of the city.

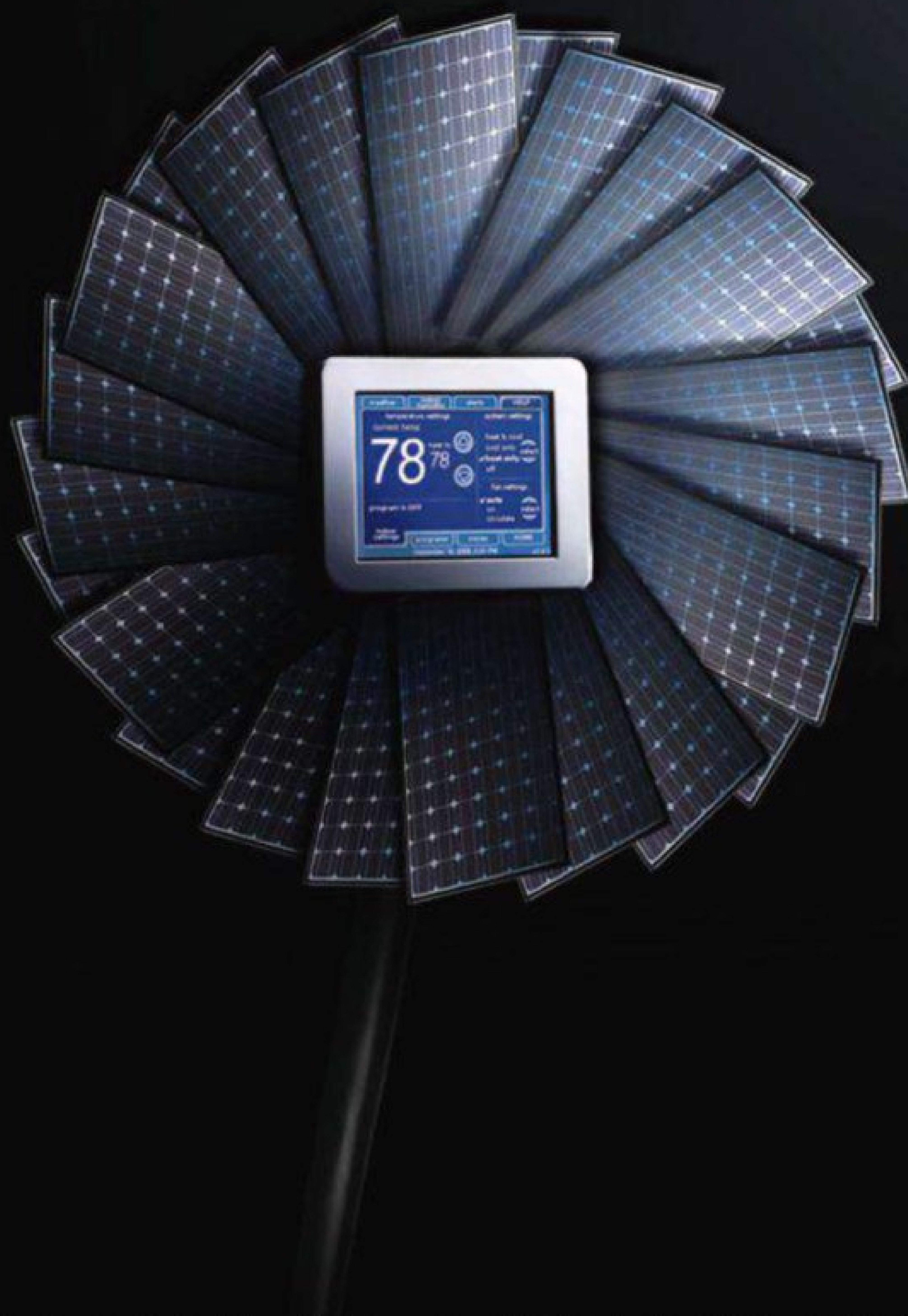


Located less than a quarter of a mile from chemical, tire and oil manufacturing plants, Ethel Street is one of the most polluted neighborhoods in Detroit.

Detroit's Fall and Potential Rise

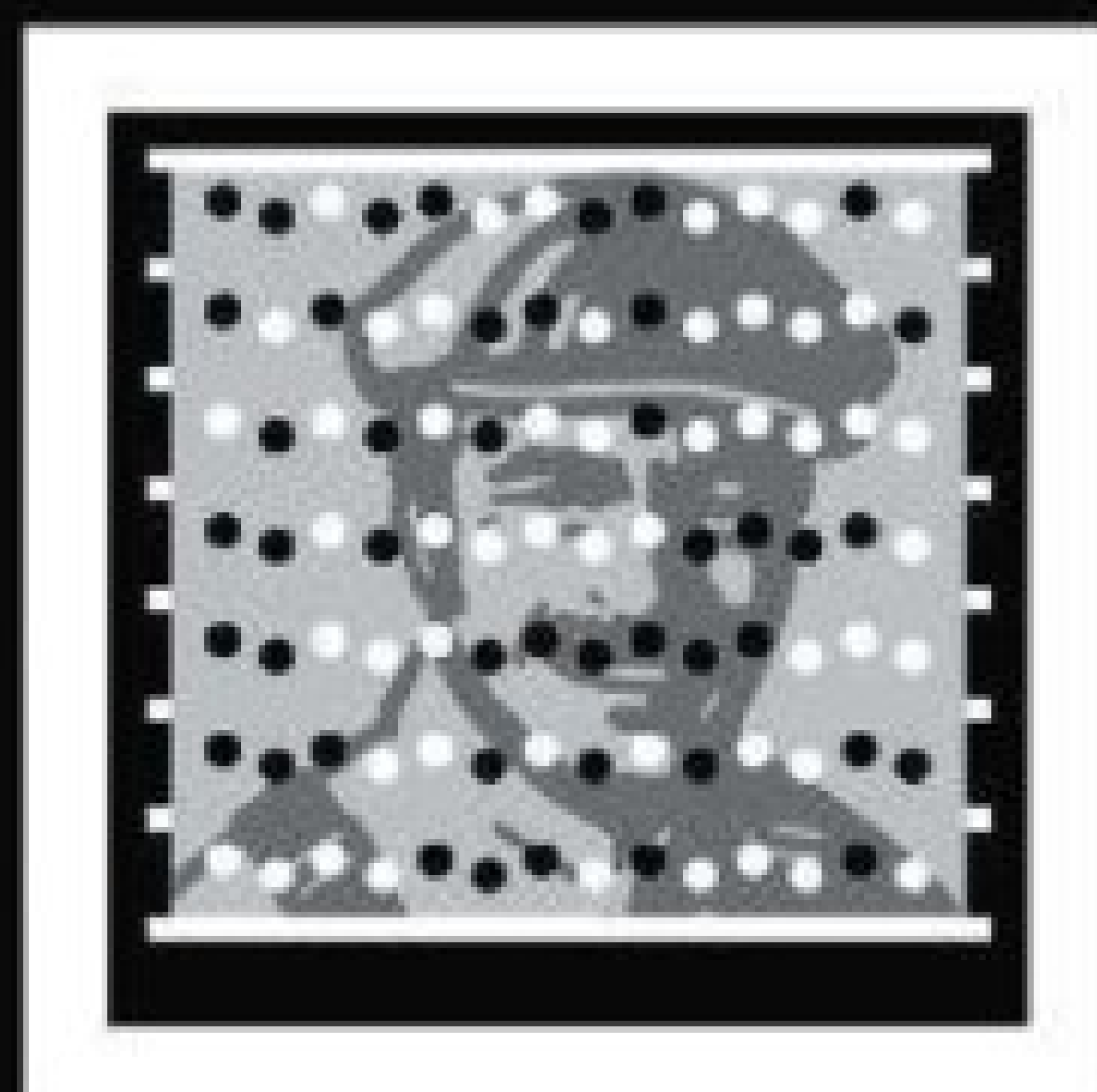
To understand the roots of this potential revival, it helps to know where Detroit is coming from. Its struggles commenced over three decades ago. The recent U.S. recession certainly didn't help, but industrial globalization, overreliance on





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“Everyone slams Detroit. But wouldn’t we be better served working to build it up instead of knocking it down?”

LORI STRICKLAND-PALMORE,
President of Rebuilding Together Detroit



one ever-changing industry and political mishandling can all share the blame for the city’s decline.

As the decline progressed, scores of people left Detroit. In fact, according to the latest U.S. Census, Detroit lost 25% of its population between 2001 and 2010. That’s 237,500 people—one every 22 minutes. It’s the largest ten-year population decline for any large city in U.S. history—second to New Orleans, post-Katrina. Jobs disappeared. Crime increased. People left to find greener pastures, literally and figuratively.

It’s easy to dwell on the misfortune. Many do. But for the people who stayed, it does not do well to dwell. “Everyone slams Detroit. But wouldn’t we be better served,” says Lori Strickland-Palmore, president of Rebuilding Together Detroit (RTD), “working to build it up instead of knocking it down?”

A Marriage Made in Detroit

Since 2005, RTD has been working to “preserve and revitalize houses and communities, assuring that low-income homeowners from the elderly and disabled, to families with children live in warmth, safety and independence.” RTD utilizes local volunteers and other organizations to fulfill this mission.

This mission could not be accomplished without help from one group in particular. “Young Detroit Builders is the backbone of RTD,” says Lori. “We could not pull off 80% of our projects without them. It’s not a partnership; it’s a marriage.”

Started in 1996, Young Detroit Builders (YDB), a YouthBuild USA-affiliated non-profit organization, helps disadvantaged young people in Detroit learn job and life skills. Its students are

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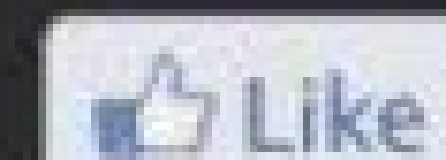
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immersed in a 10-month program, where they are taught a trade, such as construction or plumbing, from nationally certified curricula. In addition, they take classes to prepare for the GED examination, and if so inclined, classes to prepare for college.

"We help students go in any direction they want to go in," says Derrick Tagger, construction trainer for YDB. "Some may want to go to college. Some may want to be a barber, so we get them to barber school. They can be an electrician or a plumber. I wanted to be a carpenter."

Derrick's story is an interesting one. He joined YDB eight years ago, not as a trainer, but as a high school dropout who needed direction in his life. "I dropped out of school, and my mom said, 'You need to do something with yourself.' I wasn't a bad kid. I'd gotten into some trouble. Mostly, I just wasn't making good decisions. Then came YDB. It's made all the difference."

During the program, YDB students earn a modest living allowance and have access to support services, counseling and leadership development, in addition to job

and life skills training. Students are required to do 32 hours of community service. Upon completion of the program, they can get job placement assistance and are sometimes eligible for college scholarships.

"You never know when the light turns on for these kids," says Jerry Pausus, YDB construction manager, "but it almost always does, and I love seeing it shine." Like many non-profits, funding has been hard to come by. "It's been hard," says Jerry. "We used to get grants from HUD (Housing and Urban Development). Then they moved us to the Department of Labor. We haven't had a grant from them in over two years. Mostly, we work off of donations."

One interesting donation took place by way of ABC's TV show "Secret Millionaire." A wealthy real estate investor from California spent four days in Detroit, his identity hidden, working with YDB. Jerry recalls, "This guy walks in wearing a pair of shorts and sandals and says 'I want to work with kids and I want to work in construction, but I have very limited experience.'" The man worked on different job sites with YDB, installing insulation and painting. On the last day, he revealed

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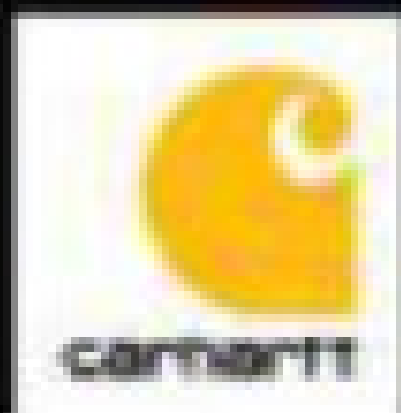
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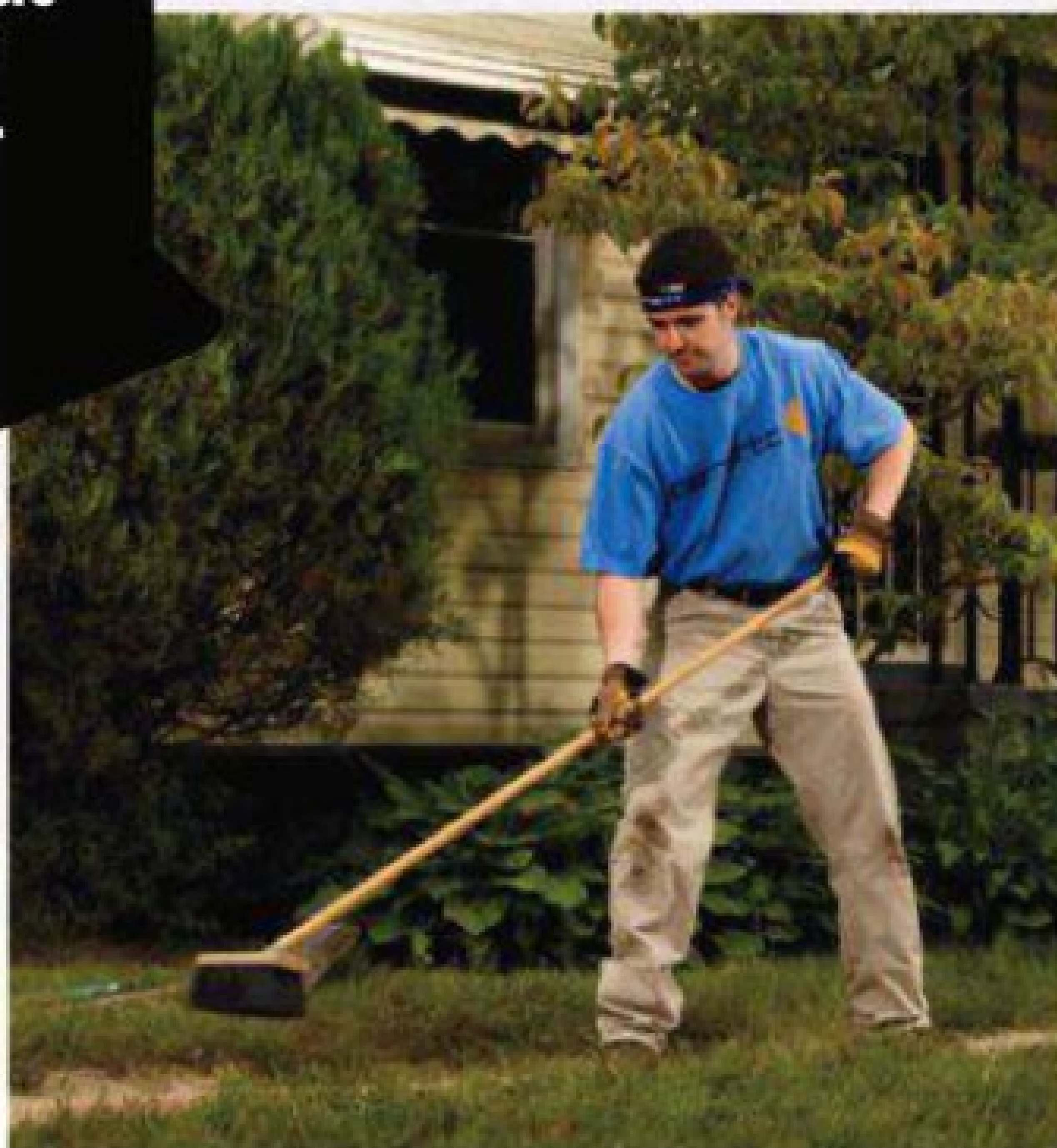
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himself. So impressed with YDB, he wrote them a personal check for \$40,000.

The money went to good use. YDB used it as a down payment to purchase their headquarters—an open warehouse, which they renovated themselves into a multi-room learning and construction facility. While we toured the facility, we caught the students at work, repairing some vinyl molding in one of the classrooms



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Southwest Detroit: A Community That Cares

Working together, RTD and YDB know that they have a lot of ground to cover. One area they each devote a lot of time to is Southwest Detroit, a neighborhood with a history all its own. As you might expect, the auto industry has a prominent role in that history. Most of the residents either work or have worked for Ford, GM or Chrysler. Others work in factories, mills, refineries, and other industrial jobs.

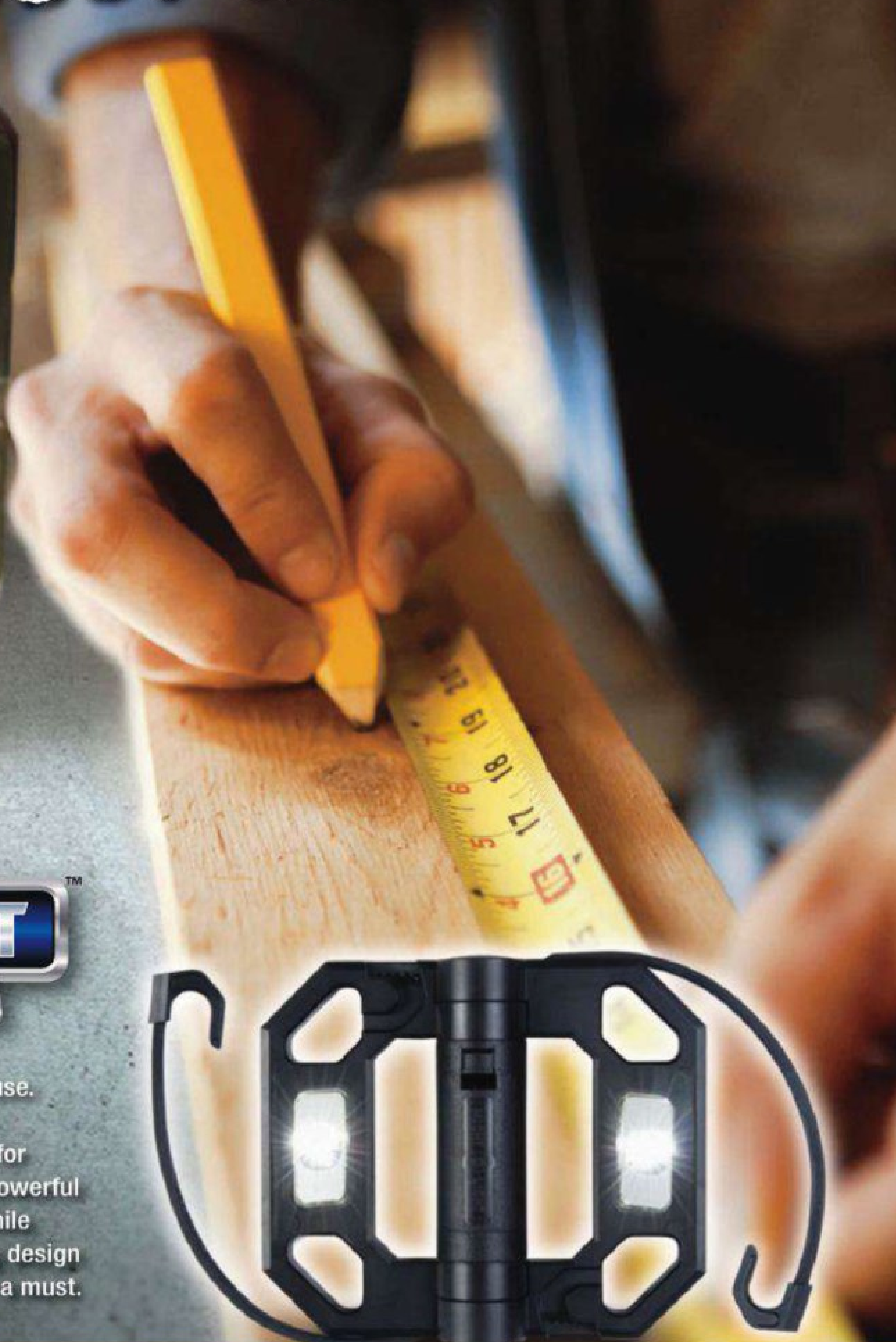
These jobs attracted a diverse group of people to the area, including a large African-American population. In fact, Ethel Street and the surrounding area was one of the first Detroit neighborhoods where African-Americans were allowed to purchase homes. It's one of the reasons why Ethel Street isn't just another street in Detroit to these residents. It's a community in the truest sense of the word.

"It's work I've needed to have done a long time ago. Now I'm just too old to get it done. I'm thankful someone can do it for me."

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Many of the residents of Ethel Street are elderly, and most have lived here since childhood, which gives them a strong sense of ownership and pride in their community. They care about their street. They care about their neighbors. They look out for one another, especially when it seems no one else is looking out for them.

Making a Change

This is not the first block build/clean-up on Ethel Street. Centered by the strong Ethel Street Block Club, and a fierce activist in Jaclyn Smith, this community has been organizing these events for years—because it's needed, and because they want a change. "Our community has to do these things.

We have to. We're all in this together," says Jaclyn.

At the end of Ethel Street, intersecting with Pleasant Street, sits an abandoned chemical plant. The company left over 15 years ago, leaving behind a giant mess. It's an area where drug deals take place, gangs hold court and gunshots ring

out. The plant's exterior walls are covered with graffiti, buildings have crumbled to pieces, and trash has littered the property. The area residents have united to clean up around the plant numerous times over the past 15 years, including this June, where they picked up trash and painted over the graffiti. But they can only do so much.

Assistance comes from Southwest Detroit Environmental Vision (SDEV), a non-profit organization that advocates for clean air, water and neighborhoods in Southwest Detroit. "When you have good neighborhoods and people who care, it's not hard to do all this," says Kathy Stott, program manager for SDEV. "It takes people working together and a bit of sweat equity."

They've also tirelessly petitioned the city of Detroit to knock down the plant. It's good to report that the community's efforts have worked. Demolition of the plant started in June.

While the sense of community on Ethel Street is strong, it's supported by a familiar ally. State Representative Rashida Talib grew up in the neighborhood and feels a familial connection. "These folks here are like my parents and grandparents. I'm like the daughter, and I have to take care of my family." But she knows that she can't do



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“When Lori told me what they were going to do for me, I wanted to cry. I couldn’t speak. From the depths of my heart, I’m just so thankful.”

MARSHA BEY



it alone. “I’ve told everyone that events like this can have a domino effect. When you start working on a house and people drive by, it can motivate them to take care of their own homes. This can inspire people to take care of their neighborhoods.”

Rebuilding Ethel Street

For the residents of Ethel Street, a golden opportunity to take care of their neighborhood arose when RTD decided to sponsor a block build on Ethel Street, with funding provided by Popular Mechanics. Prior

to that date, RTD and Ethel Street Block Club members distributed applications to interested residents, and those who met the requirements set by the national Rebuilding Together organization were approved for home repair. “Two of my neighbors, my friends, told me about it and brought me an application,” said Hermine Cobb, a resident of Ethel Street for 56 years. “I’m happy it got approved and all this work is being done to my house.”

Any rebuilding effort starts with supplies, and this entire initiative owes a huge debt of gratitude to Lowe’s Home Improvement. The retailer generously provided supplies, such as toilets, a power washer, a water heater, windows and numerous other products.

In Hermine’s house, the kitchen was refitted with a new sink and a new Delta® kitchen faucet to replace the original fixtures. In addition to manufacturing superior products, Delta® is an extremely generous corporate partner, and as you will soon see, took care of multiple homeowners on Ethel Street. Kitchen cabinets, five new windows and a new washer and dryer set were also installed. Outside work included replacing old gutters and fraying window

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screens, putting new carpet down on the front porch, and installing planters in the backyard. New steps were built onto the back porch.

The next house to be worked on belonged to Marsha Bey, whose family has lived in the same home since 1952. Over time, many things fell into disrepair, particularly on the outside. Workers spent hours cleaning up the yard, removing debris and yard waste, cutting out old tree roots, and cleaning out gutters.

Here, Lowe's again pitched in, supplying a ReliaBilt exterior door to replace the existing, weather-beaten door at the side entrance to the house. These doors offer maximum durability and also feature added insulation that will undoubtedly make a difference next winter. Outdoor lights from Cooper Lighting® were installed in the front of the house. They were incredibly easy to install and will

provide Marsha considerable savings on energy costs over the life of the products, in addition to added security.

On the garage, workers fastened wiring from the lights with an Arrow Fastener T50 Elite™ staple gun. Volunteers loved the product, noting the great feel of the ergonomic grip and the "ease of the squeeze." Once that was done, the garage itself was cleaned out and organized, and a new garage door was installed. Funding and support for this came courtesy of Valvoline NextGen. In addition to making top-of-the-line motor oil products, Valvoline has made a corporate commitment to both giving back to the community and supporting the environment. When the project's RAM truck needed an oil change, we of course used the company's NextGen product, which is 50% recycled. Every garage in America can use a few bottles of NextGen.

Speaking of the RAM truck, this project would have had serious difficulties were it not for the 2011 Power Wagon Crew Cab that RAM generously loaned us.

Workers also repaired and painted a wood fence, and touched up trim around the house, and awnings in front and on the side using Kilz® Premium Interior/Exterior Water-Based Primer/Sealer/Stainblocker. Year in and year out, Kilz® supports our Rebuilding Together initiatives, and its product line never disappoints the teams of volunteers. Its primers are ideal for surface prep, stain blocking, and sealing porous surfaces.



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Lennox® kindly donated a Merit Series 13ACX air conditioning unit to replace the existing unit, which had not worked

in three years. Every component in the 13ACX is designed for durability and easy maintenance year after year. And once it's installed, its industry-leading warranty coverage adds another layer of protection. Working in tandem with the new Reliabilt door, this home received a huge overall upgrade in energy efficiency.

Inside, a dilapidated faucet was replaced with a Delta 3-hole bathroom fixture, and the bathtub was re-caulked. Workers outfitted in rugged Carhartt® work clothes repaired a rotting

wall that stretched from the dining room to the kitchen. Carhartt® apparel is strongly recommended for any volunteer day of this sort (or any DIY project for that matter) due to its unique combination of comfort and durability. And the brand's pricing is extremely consumer-friendly.

Next, Marie Nance's house got quite the kitchen makeover, with a new Delta faucet and a new kitchen floor. She also had a new toilet and two new windows installed. Workers also put in a new closure on the front door, repaired gutters, and performed some minor siding repair. Using FrogTape® and its PaintBlock® Technology to seal the tape's edges to prevent paint bleeding, workers painted a light post in her yard and iron railings on her front porch. FrogTape® is the only painter's tape treated with PaintBlock®, a super-absorbent polymer which reacts with latex paint and instantly gels to form a micro-barrier that seals the edges of the tape, preventing paint bleed.

Susie Harvey's well-kept house required only a few repairs, including a Delta faucet in her kitchen, two grab bars in her showers, and a programmable thermostat for her central air unit. Workers also repaired a step leading up to her side door and bolstered the fence around her yard.

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"I barely have the words to describe it. It's just beautiful."

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*KILZ brand received the highest numerical Equity Score, Trust Score and Quality Score among Paint Coatings included in the 2011 Harris Poll EquiTrend® Study. Please go to www.kilz.com for further details.

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◆ ◆ ◆ ◆ ◆
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GUTS-GLORY



For Robert and Jaclyn Smith, workers put in a Delta kitchen faucet and built support rails along the stairs in the basement and in the bathroom. A banister along the stairs to the second floor was also repaired. Outside, workers re-laid a cinderblock walkway, completely removed a chain link fence, weather-stripped the front door and fixed a leaky front awning. Both the garage and siding were power washed.

In an area where nearly everyone worked in an industrial plant, Myra McWilliams represented Ethel Street's Motown roots. "My dad was a musician and played all the clubs in the city, and my sisters and I did the same. It was a fun time." In her home, workers installed a new toilet, grab bars in the bathtub, and support railing along the stairs to the basement and to the second floor. Outside her home, workers painted her front porch and the surrounding foundation, and a brick walkway was re-laid to provide a safe path for her to walk.

Delores Hall and her family received new ceiling tiles in various parts of the house and new floor tiles in the utility room. Delta provided new hardware in the kitchen, and an additional new faucet in the bathroom. Outside, workers repaired

Working together on projects like Ethel Street, the Young Detroit Builders develop the skills, knowledge and friendships needed to go farther in life.




the steps leading from the back porch and repainted the foundation.

A Microcosm of the Bigger Picture?

As we mentioned at the beginning, there is potential for improvement here. Things are happening in at least some parts of Detroit. The homeowners featured in this story are now more comfortable, and energized by the prospect of a new tomorrow. Greener, money-saving products have been implemented, which bolsters quality of life and improve the environment. And there is unlimited potential for much more revitalization and home improvement all around the city. With the dedicated people of Rebuilding Together Detroit and Young Detroit Builders serving as role models for progress, things can and most certainly will get better.

◆ ◆ ◆ ◆ ◆
 The revival is taking place.
 Let's all be a part of it.



“What I’m proud of is that we’re cleaning up down here and trying to make a change.”

DANTEZ GARRISON

How You Can Help

Each one of the organizations involved with this project needs help overcoming the biggest challenge, “the convergence of growing needs with shrinking resources,” says Bob Blumenfeld, vice chairman of the board of RTD. You can help. Donations and volunteer help are readily accepted.

REBUILDING TOGETHER DETROIT:
rebuildingtogethertdetroit.com
or call 313-237-7212

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youngdetroitbuilders.com
or call 313-256-7291

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or call 313-842-1961



WHAT REALLY HAPPENED IN
AREA 51

...



Though it's just a small part of a sprawling complex that includes a nuclear test site and a military base, Area 51 has had an outsize reputation since its inception, in 1955.

BY EARL SWIFT

AMERICA'S NOTORIOUSLY SECRETIVE MILITARY COMPOUND RETURNS TO THE LIMELIGHT, THANKS TO A NEW BOOK THAT MAKES FANTASTIC CLAIMS ABOUT ITS PURPORTED UFO AND ALIEN PAST.

PHOTOGRAPH BY ERIC OGDEN

UP IN THE DESERT ABOVE LAS VEGAS HIDES A DUSTY AIR BASE RINGED BY towering mountains, buffered by an atomic testing preserve and guarded around the clock. It isn't much to look at—a knot of hangars, fuel tanks and prefab living quarters beside a dry lake-bed and a long runway. The parched ground sprouts little but creosote, scorpion weed and the odd Joshua tree.

But for generations, this lonely outpost has itched some people like a bad case of poison ivy. Secrecy about what goes on there has fueled all manner of speculation: It's a port for visiting spacecraft, or a venue for alien autopsies, or a lab where captured UFOs are reverse-engineered

to America's military advantage. An industry has sprung up around this guesswork—TV tell-alls, books and websites by the dozens. The public appetite for conspiracy theories involving Area 51—aka Groom Lake, Dreamland, Homey Airport, Paradise Ranch or Watertown—appears insatiable. Reasonable people, smart people, eat them up.

So when a book comes along that promises to really, truly explain the place, and said book is by a contributor to the *Los Angeles Times Magazine* and put out by a major publisher and wins praise from *The New York Times*, NPR and national TV shows (*Fox & Friends* called it “an incredible piece of journalism”), we can't help but take notice.

For much of its 523 pages, Annie Jacobsen's *Area 51: An Uncensored History of America's Top Secret Military Base* is the story of the men who, starting in 1955, developed and tested secret Cold War reconnaissance aircraft at Groom Lake—the CIA's U-2 and A-12 Oxcart, the latter of which flew with modifications as the Air Force's SR-71 Blackbird. Jacobsen interviewed 74 people, including 32 who lived and worked on the base. Many of them belong to Roadrunners Internationale, the alumni association of Groom Lake pilots, engineers, mechanics and such. The Roadrunners gladly spoke to her: Their Cold War activities had recently been declassified; they were getting on in years; they wanted their achievements recorded.

“We were very, very happy with what she was doing,” T.D. Barnes, a radar expert and the Roadrunners' president, told us. “She did a great job of researching. She did everything a good journalist would do.” Retired U.S. Air Force lieutenant colonels Roger W. Andersen and Francis J. Murray were also impressed; Murray said Jacobsen “was constantly taking notes” and “really seemed to be making sure that what we told her was correct.” But for all of Jacobsen's apparent diligence, the men were surprised, and not happily, by the finished product: After Barnes read *Area 51*, for instance, he denounced her in a blog post as “an author who refuses to repent her literary crimes and errors.”

The focus of the Roadrunners' criticism is a UFO conspiracy theory so fantastic that it makes the infamous and historically discredited tale about a 1947 crash of a flying saucer in Roswell, N.M., seem tame. The bottom line of the traditional Roswell story is that the purported extraterrestrial UFO wreckage was taken to Area 51 and subsequently became the object of a massive government coverup. Relying on the testimony of a single unnamed source, Jacobsen's book repeats the claim that some sort of UFO crashed at Roswell. But in her telling, the craft wasn't of alien origin. Instead, it was a saucer built by the Soviets using technology they'd obtained from German engineers at the end of World War II. And there's more. According to her unnamed source, the craft was manned by human teenagers who had been medically altered to look like aliens, with giant heads and eyes like wraparound Oakleys.

Who would do such a thing to children? Why, notorious Nazi death camp doctor Josef Mengele, Jacobsen writes, quoting her source quoting another source or sources, also unnamed. Seems that Mengele was working for Soviet boss Josef Stalin, who needed the mutants for a special project: scaring the daylights out of America with a fake alien visitation. Yes, it was all a hoax, the most lavish prank in history.

Jacobsen reports that the wreckage was moved from Roswell to Wright Field (now Wright-Patterson Air Force Base, near Dayton, Ohio), where it was kept until 1951, then moved to the Nevada desert. There, her unnamed source was part of a team studying the saucer. They discovered that it ran on “electromagnetic frequency, or EMF,” Jacobsen quotes him as saying, and he claims America has had the technology since. She offers no details on how this “EMF” propulsion might work, and the term could mean almost anything. All forms of electromagnetic radiation—radio waves, visible light, X-rays and more—operate at particular frequencies. The notion that devices such as airplanes might be powered remotely by electromagnetic energy is at least a century old. But the concept has never worked on a large scale—the quantity of energy required would be unimaginably large.

One more thing: Two “child-size aviators” from the craft, alive but comatose, wound up in the desert too. They were stored in gel, the unnamed source told Jacobsen, and they moved their mouths as if trying to speak. Why would America hide the fact that Mengele had produced these sad creatures at Stalin's behest? “Because,” the source tells Jacobsen, “we were doing the same thing . . . We per-

formed medical experiments on handicapped children and prisoners,” and we did it “at least through the 1980s.”

Jacobsen offers no corroboration for this; instead, she presents irrelevant information that has been trotted out for many years by Roswell alien UFO conspiracy theorists. She writes that she pressed her source

THE AUTHOR ASSERTS THAT JOSEF MENGELE WAS WORKING FOR SOVIET BOSS JOSEF STALIN, WHO NEEDED THE MUTANTS FOR A SPECIAL PROJECT: SCARING THE DAYLIGHTS OUT OF AMERICA WITH A FAKE ALIEN VISITATION. YES, IT WAS ALL A HOAX, THE MOST LAVISH PRANK IN HISTORY.

for details of the horrors he saw at Area 51, but he wouldn't budge. "He said he was hurting," Jacobsen writes. "That soon he would die. That, really, it was best that I did not learn any more because I didn't have a need-to-know."

Could this be true? Could any of this be true?

Let's start with the flying saucer, which Jacobsen ascribes to German aeronautical engineers Walter and Reimar Horten. It's a fact that before and during the war, the Horten brothers built a series of ever more sophisticated all-wing aircraft, culminating with the jet-powered Horten 229, a boomerang-shaped contrivance that bore a passing resemblance to Jack Northrop's YB-49 bomber prototype of the late '40s, as well as to the U.S. Air Force's much more recent B-2 Spirit stealth bomber.

Jacobsen writes that the brothers might have been at work on something more ambitious at war's end, and that the invading Soviets might have seized their blueprints. Within a few pages, she refers matter-of-factly to "the Horten brothers and their advanced flying saucer." Jacobsen cites postwar German sources who described and even sketched what she calls "saucer-like" craft. One was shaped like a half-moon, another, according to "Professor George," was "very much like a round cake with a large sector cut out."

We searched for evidence, finding none, that the brothers created a true flying saucer. (The book includes a photograph of the Hortens' Parabola, an all-wing, parenthesis-shaped craft with rounded edges; the photo is suggestive but its relevance to the story not explained.) We consulted with David Myhra, an aviation expert whose books include four on the Hortens, and who spent several weeks with Reimar Horten at his ranch in Argentina in the 1980s. "The Horten brothers never, ever went to any kind of a circular aircraft design," Myhra said. "There were no flying saucers in the Horten line, at all."

Jacobsen spoke with Myhra several times while writing *Area 51*. When Myhra read the book's claim about the Horten disc, he told us, "I thought, this is a piece of science fiction."

Next up: the mutant pubescents inside the crashed saucer. Quoting her unnamed source, Jacobsen writes that Stalin tapped Mengele, the infamous "Angel of Death" at the Auschwitz concentration camp, to create the faux aliens "shortly before or immediately after the end of the war," and that in exchange the Soviet leader offered the Nazi safe haven and a place to work, but later reneged on the deal.

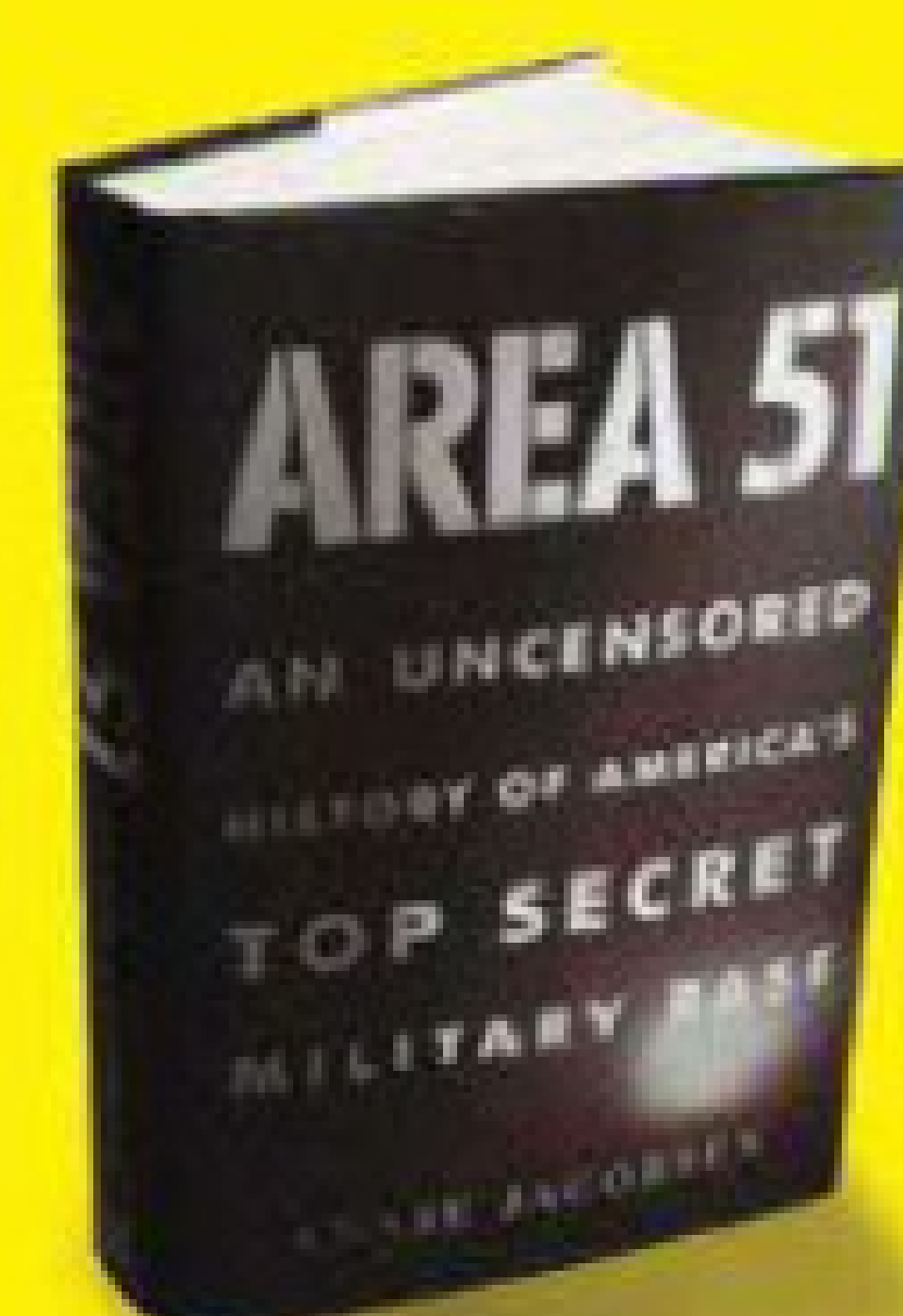
There's a lack of common sense in this yarn. The cliché that aliens are small, Twizzler-limbed beings with outsized noggins and buggy eyes came along years after Roswell, thanks notably to Steven Spielberg's 1977 film, *Close Encounters of the Third Kind*. Until then, they were almost exclusively portrayed as proportionally humanoid, robotic or (in the case of H.G. Wells's 1898 book, *The War of the Worlds*) tentacled. So why would Stalin place children with surgical makeovers in the saucer? He could have incited a panic, if that had been his aim, using a seasoned Soviet pilot who'd undergone a little nip and tuck.

Then there is historical fact. No evidence exists that Mengele had the medical skill to perform such transformations, much less the time to do them. He arrived at Auschwitz in May 1943 and served as chief doctor in the Birkenau subcamp, where he selected incoming prisoners for slave labor or the gas chamber. He also conducted horrific medical experiments, including some on dwarfs and twins. His activities during this time are extremely well-documented. He was not building aliens.

With the Red Army nearing Auschwitz in January 1945, Mengele fled to another camp, Gross-Rosen, then retreated farther west with a field hospital unit until his capture by American troops. After several weeks in custody, Mengele was released and devoted himself to keeping his head down, first as a farmhand in Bavaria and later near his hometown of Günzburg. He stayed there until he slipped off to South America, in 1949. To sum up: According to Mengele biographer Gerald L. Posner, the doctor was fully occupied—sorting potatoes and baling hay in rural Germany—during the nearly two years before the supposed Roswell crash.



T.D. Barnes (above) was a radar expert at Area 51; today, he is the president of Roadrunners Internationale, an organization of men who worked at the base. Air Force officers displayed the remains of a weather balloon (left) found near Roswell, N.M., in the summer of 1947 to quell UFO stories.



Area 51 initially received some good press, but its claim that the alleged Roswell UFO was a Soviet craft with mutant teenagers aboard made us wonder: Did those critics actually read the thing?

AREA 51 HARDWARE.

Never mind the conspiracy theories. The hype surrounding Area 51—about alien autopsies, reverse-engineered spacecraft and more—often obscures the impressive feats of aeronautical engineering accomplished there.

SR-71 BLACKBIRD: The U.S. Air Force's high-altitude reconnaissance aircraft flew faster than Mach 3, outrunning most surface-to-air missiles. The squat profile, a special skin and a cooler exhaust plume were intended to thwart detection by radar or infrared sensors. The SR-71 was not tested at Area 51, but the plane's design and engines were identical to those of the CIA's A-12 Oxcart (below).



U-2 Nickname: Dragon Lady. It's hard to fly and harder to land, but the images it captured from 70,000 feet were worth the risk to pressure-suited pilots. The U-2 is still flying, 56 years after its introduction, proving its ingenuity and utility.



MIG-21F In Area 51's Have Doughnut project, a Soviet-built MiG-21F acquired in 1968 was evaluated and used by U.S. pilots in combat test flights. Have Doughnut was hugely successful, leading to the famed Red Flag and TOPGUN training programs.



A-12 OXCART First flown in 1962, the CIA's A-12 broke the Mach 3 barrier in 1963. A fatal crash that year was painstakingly covered up and later fueled conspiracy theories.



Now, about the saucer's hardware. Jacobsen writes that Stalin wanted to scare the States because he was lagging in the Cold War arms race: Two years away from being able to field an A-bomb, he deployed the saucer as "a warning shot across Truman's bow," she quotes her unnamed source as saying—a nudge to the U.S. president that the Soviets had technological tricks of their own.

This raises several questions of logic. If the Soviets were struggling with nuclear fission, how likely is it that they'd mastered the EMF technology that supposedly drove the saucer? If they had mastered EMF, why would they crash or land the saucer on U.S. soil, thereby making a gift of the technology to their greatest rival? If both the U.S. and Russia have had EMF technology for 60-plus years, why are we still flying old-school, fuel-chugging planes? Why did we use Hueys in Vietnam? Why didn't we use EMF to power the space shuttle?

But onward: Jacobsen writes that her unnamed source was one of five engineers to eyeball the crashed saucer at a secret research facility in the desert in 1951, four years before the Groom Lake air base opened a short distance away. He saw Cyrillic lettering "in a ring running around the inside of the craft," she reports. There were controls in the cockpit, but the craft was apparently flown by remote control.

We called Peter W. Merlin, an aviation historian who's written much about Groom Lake, including *X-Plane Crashes: Exploring Experimental, Rocket Plane, and Spycraft Incidents, Accidents and Crash Sites*. (It's safe to say he knows his stuff about the downing of some very unusual flying machines.) Merlin shared with us an October 1952 aerial photo of the area shot by the U.S. Geological Survey. The photo, he noted, "shows nothing there" but an abandoned World War II airstrip. "All the well-documented his-

torical narratives show that Area 51—not by that name, but as a facility—was built in 1955," Merlin said. As for who was piloting the alleged saucer: Wireless, remote-control technology was just a few years old in 1947; it wasn't yet available on American TVs. So does it make sense that the Soviets would have used it to guide an aircraft from thousands of miles away?

When we first spoke with Jacobsen, three days after the book's release, we asked whether she realized this story might strike some people as "pretty nutty" (our exact words). She answered that she did. "The whole thing sounds so preposterous, [but] the reason I chose to include it in my book is that I believe in the veracity of my source," she said. "I've worked with him now for two years."

Mr. X is a man with impeccable credentials and a storied career, she told us: He'd devoted his adult life to serving the Manhattan Project and the Atomic Energy Commission (AEC), much of it as an engineer for defense contractor EG&G. "I've examined his Atomic Energy Commission awards and certificates," she said. "I examined his war record, his military records, his medical records."

She wouldn't tell us his name, of course. She'd promised to stay mum about his identity and those of the four now-deceased engineers with whom he'd worked. Jacobsen said she realized that using an unnamed source had earned her some skepticism, but argued it was "part of journalism, historically."

Skepticism or no, Jacobsen's book was enjoying a lot of friendly press at the time. Within a few days of our conversation, the hosts of CNN's *American Morning* said they "couldn't put it down" and found it "riveting." MSNBC's *Morning Joe* heralded the book's runaway sales. *The New York Times* praised Jacobsen's "dogged devotion to her research" and called the Roswell passages "a hasty-sounding addendum to an otherwise straightforward investigative book about aviation and military history."

But the tide turned. On May 26, when Jacobsen appeared on ABC's *Nightline*, reporter Bill Weir challenged her Soviet saucer tale, asking, "How can you believe this?" He requested to meet her unnamed source, and did so. Weir reported that he was as esteemed as Jacobsen had described, but Weir opted to keep the man's name and image off the air because he'd seemed "confused."

Meanwhile, speculation about the identity of Jacobsen's source proliferated on the Web. Well, actually, on dozens of websites. The man in question figures prominently in Jacobsen's book, and, indeed, the details she put down about him jibe with her descriptions of Mr. X to us and to others. So we phoned his home. His wife answered. Upon hearing what we wanted, she referred us to a publicist at Little, Brown and Company, *Area 51*'s publisher. She then said that her husband was in the hospital after suffering a fall, and that she'd take our number to him. "I doubt if he'll talk," she said. "Everybody says he's the man, but he'll say he's not."

"Is he?" we asked.

"No, no, I believe that he's not," she said. "This whole thing has just got out of hand." He never called, and our subsequent attempts to contact him have been unsuccessful.

When we spoke to Jacobsen again in early June, we mentioned that Mr. X's name had been bandied about on the Internet. "I imagine there's a zillion websites that are speculating about who my source might be," she said, "but I have no idea. I don't read them, and I don't know about any of that."

We asked whether it had occurred to her, while talking with her source, that his story had some problems. "If I ever had a question like that of the source, I asked him," she replied.

We asked whether she'd come to harbor any misgivings about his account since. "I believe that what the source told me is true, to him," she replied. "In other words, everything that he told me, I believe in his veracity as an individual."

Her book's endnotes, she reminded us, did raise "the possibility that perhaps some of the information that he was told could have been misinformation." Her source didn't think so, however, and was "surprised and upset by the idea that no one believes this," she said.

In our second conversation, Jacobsen complained that her critics were fixated on "the last seven pages" before the epilogue, rather than the hundreds previous chronicling the impressive military aircraft development at Groom Lake. And indeed, the most sensational elements of the Roswell-Soviet-Mengele bombshell come in an ending that took the Roadrunners by surprise.

"The general reaction of most of the guys I know is: Wow. We didn't see this one coming," Roger Andersen said. "We really got back-doored on that last chapter." Roadrunners vice president Harry A. Martin offered a more forceful assessment. "We don't go along with that crap," he said. "I don't appreciate it, really." Retired U.S. Air Force Lt. Col. Tony Bevacqua, who flew the U-2, called the book's last chapter "flat-out unbelievable." Francis J. Murray branded it "BS."

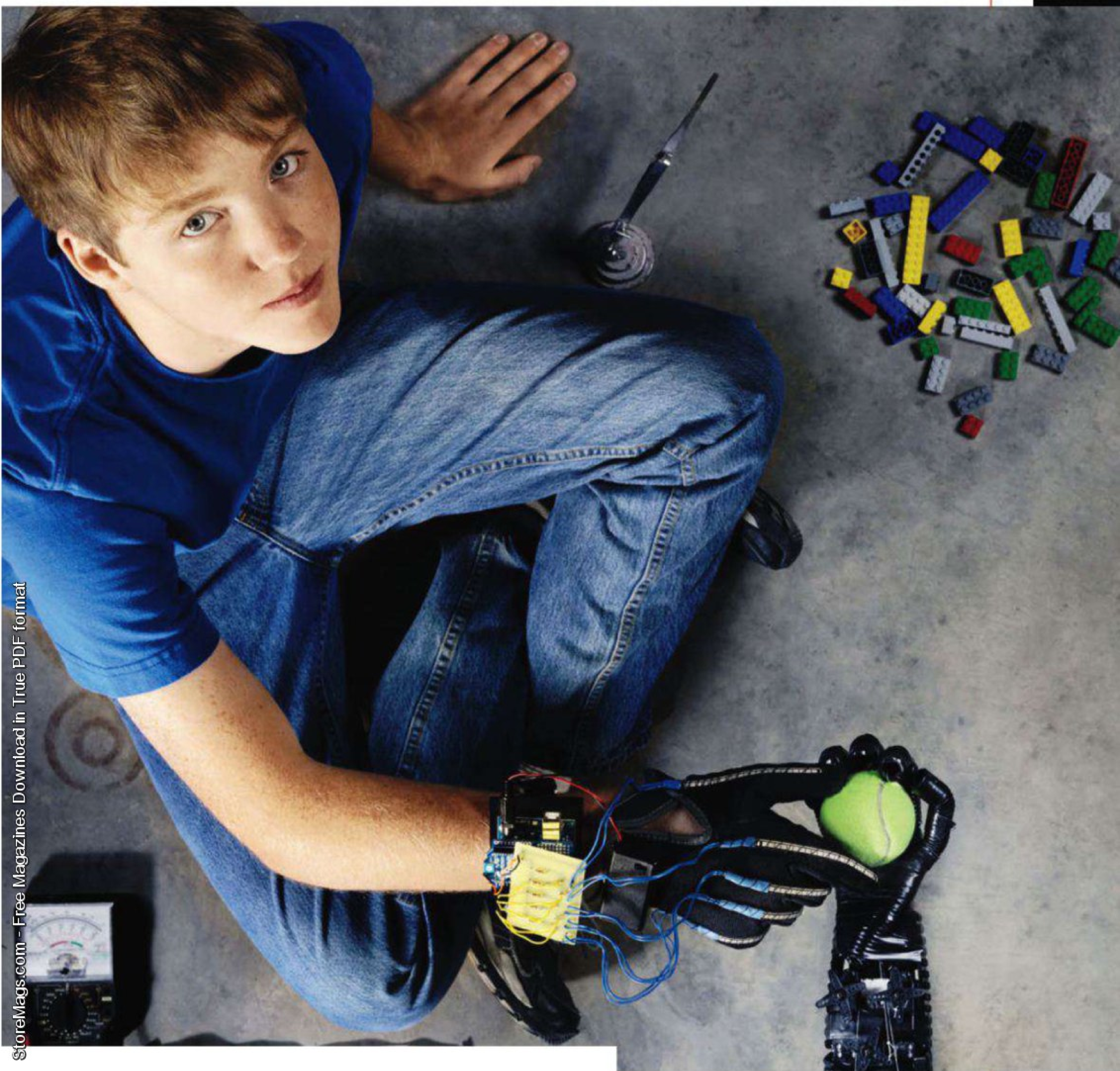
Some Groom Lake alums, mindful that the book contained their story, decided they'd back it anyway, and have appeared with the author at book signings and TV tapings. Barnes is among them, though he said he was "horrified" when he read *Area 51* and regretted introducing Jacobsen to some of her other sources. On Memorial Day he made the blog post decrying Jacobsen's "literary crimes and errors." (He has since removed the page containing that quote.)

Meanwhile, Jacobsen is unwavering. "Everybody has opinions about



Testing of nuclear bombs, including the 74-kiloton Hood device, which was detonated on July 5, 1957, took place at Area 9 of the Nevada Test Site, near Area 51. Here, the bomb is held aloft by a balloon.

Easton LaChappelle's wireless animatronic hand is his first stab at the concept; he's already working on an entire mechanical arm.



THROWING DOWN THE GAUNTLET

drawings to better understand finger joints and movement, then created a wirelessly controlled mechanical hand. The fingers are constructed of flexible wire tubing, while the "wrist" is reinforced with Lego bricks. Fishing wire runs through the tubing from the fingertips to five independent servos, providing the hand's motion. Next, LaChappelle sewed flex sensors into a standard athletic glove and wired them up to a custom Arduino controller board and shield. The shield sends wireless signals to a receiver on the animatronic hand. The whole setup works without a computer interface and costs only around \$350. "Some strength is lost because of the materials I used," LaChappelle says, "but I can pick up a full can of soda with it."

Put away your baking soda volcano—this kid built an animatronic hand. For his high school science fair project, Easton LaChappelle studied anatomical

PHOTOGRAPH BY **MISHA GRAVENOR**

Release: StoreMags & FantaMag

BACK YARD

GENI US 20 11

THE MOST
ANIMATRONIC,
ECOLOGICAL,
MICROSCOPIC,
HYDRAULIC,
RHYTHMIC,
JET-POWERED,
HOME-BREWED,
JURY-RIGGED,
HIGHLY FLAM-
MABLE, ROBOTIC,
ODDBALL
CREATIONS OF
THE YEAR.

BY DAVIN COBURN

EASTON LACHAPPELLE
Location: MANCOS, COLO. Age: 15

BONGO SUIT

Lucas Werthein lives in Brooklyn, N.Y., but his thoughts are never far from the rhythms of his native Brazil. A chance encounter in January allowed him to jump back into its music.

Werthein, a graduate of the interactive telecommunications program at NYU, was visiting friends back home when he met the legendary percussionist Carlinhos Brown. Brown, who comes from Salvador in Bahia, was to perform at Salvador's Carnival in March, and wanted something to amaze the thousands in attendance. Werthein had just the idea.

He and his collaborator, Kyle McDonald, designed a full bodysuit with 10 embedded piezoelectric drum pads. "Carlinhos would hit his body to describe the sounds he was looking to reproduce," Werthein says, "so a suit made sense."

As Brown played in front of 100,000 people, the suit—called EletroAxé, for an electronic form of the Bahian musical style—wirelessly transmitted the sounds of traditional Brazilian percussion instruments (bacinhas, surdos), as well as a few nontraditional ones (lasers, bomb explosions).

Lucas Werthein (right) and Kyle McDonald created a drum-pad jumpsuit that was used to make music for a Brazilian Carnival.



LUCAS WERTHEIN

Age: 26

KYLE MCDONALD

Age: 26 Location:

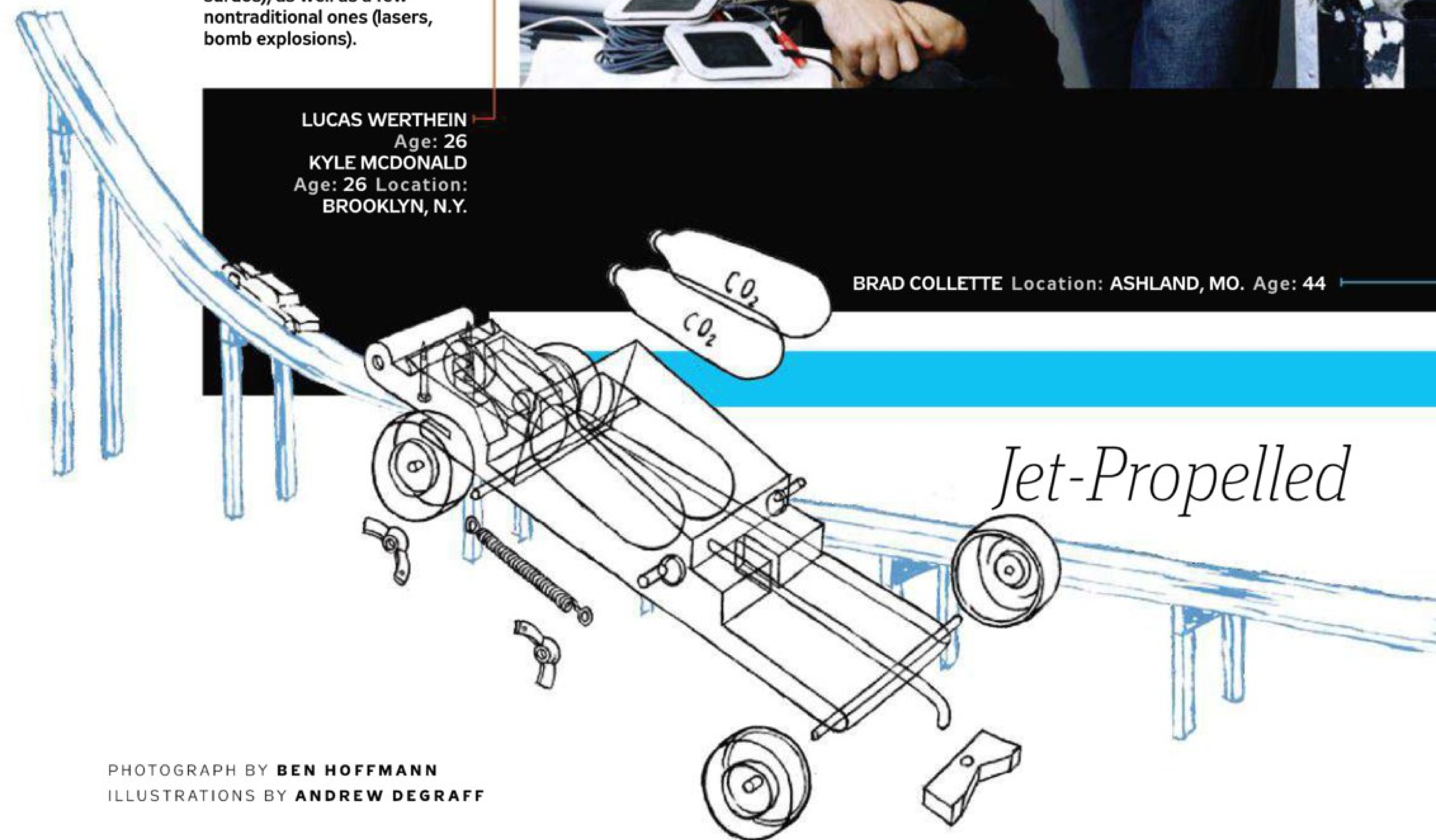
BROOKLYN, N.Y.

BRAD COLLETTE Location: ASHLAND, MO. Age: 44

Jet-Propelled

PHOTOGRAPH BY **BEN HOFFMANN**

ILLUSTRATIONS BY **ANDREW DEGRAFF**



BRIAN "ZIGGY" LILOIA
Location: RUTLEDGE, MO. Age: 27

CIRCULAR LOGIC

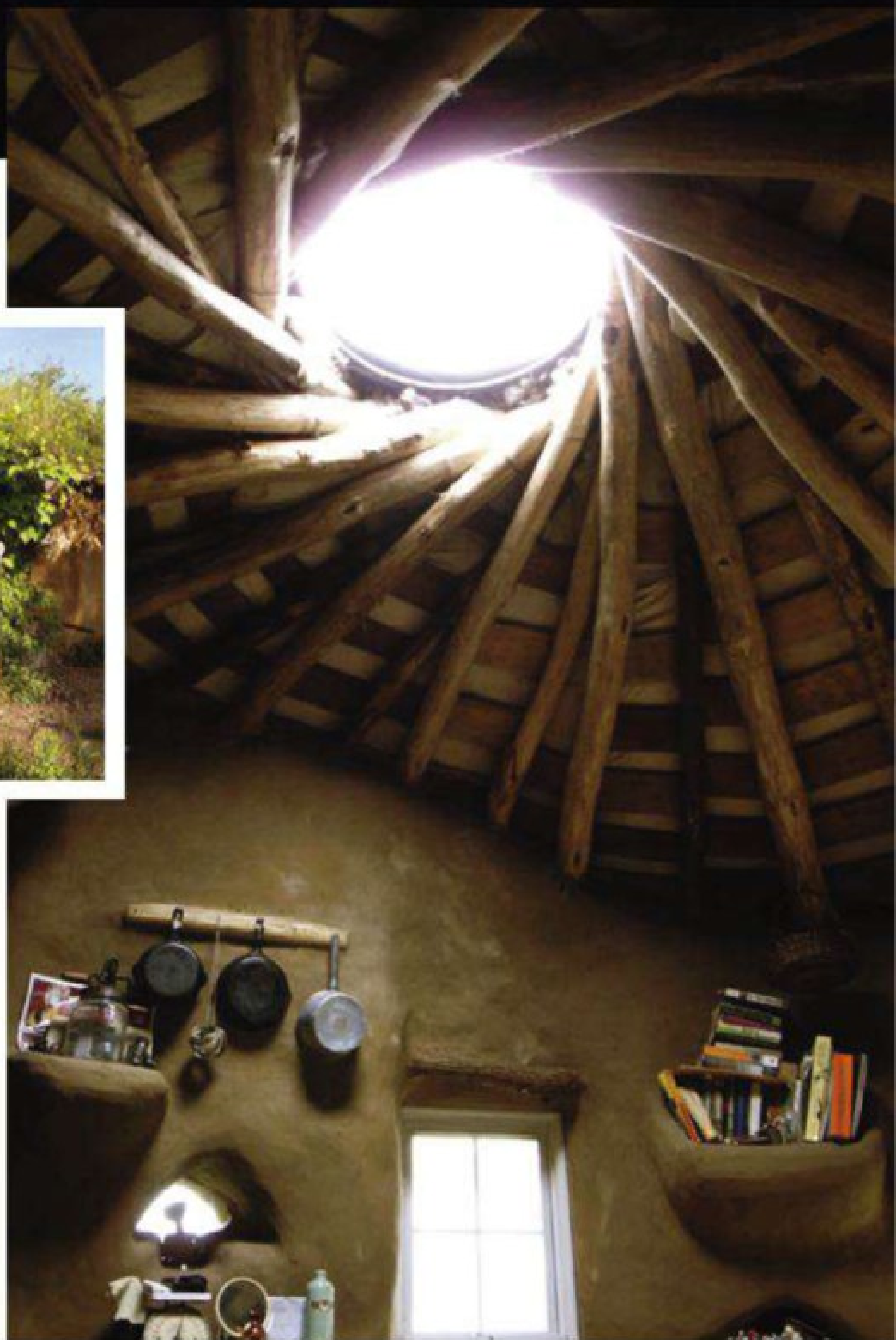
Four years ago, New Jersey native Brian Liloia moved to rural Missouri to master the art of building with cob, an ancient combination of clay, sand and straw. The incredibly strong material is perfect for creating sustainable architecture. Cob is even mashed by foot. "I knew it was going to be a lot of work," Liloia says, "but I really wanted the knowledge that comes from doing something with your own hands and feet."

Soon he and girlfriend April Morales were stomping cob to build their first home: a 200-square-foot hut. The crowning touch was a reciprocal roof made with 28 black locust and oak poles. The radially arranged poles support, and are supported by, each other—no internal



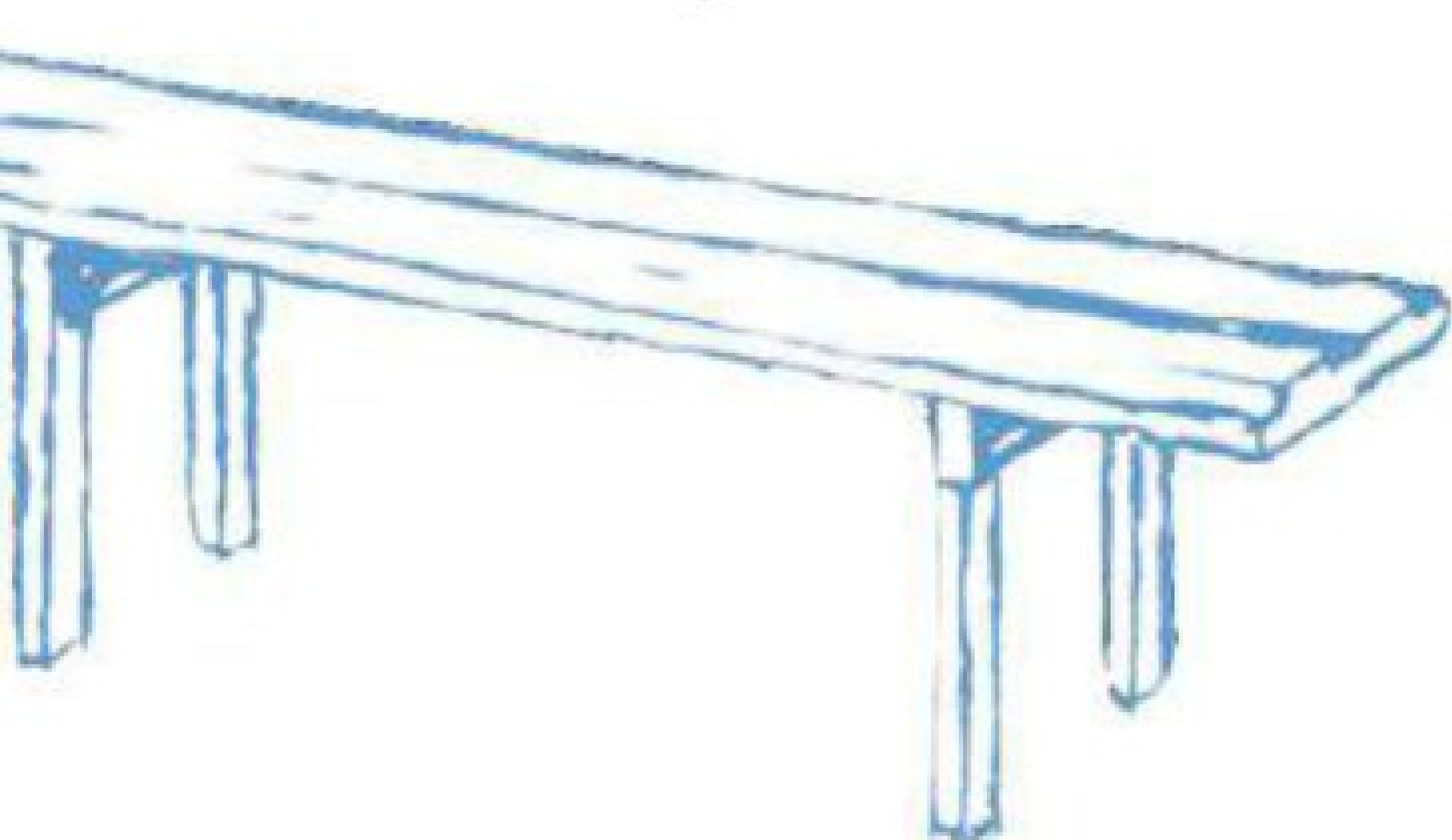
columns required. In the center, a tractor tire frames a pair of polycarbonate sheets to form a skylight. Total cost, including the later mudroom addition and a new stove? About \$4000.

"When I first told my family I wanted to live here, they were flabbergasted—but now that they've seen the house, they realize the value in it," Liloia says. He pauses. "But my mom probably still thinks it's a little weird."



The rafters of Brian Liloia's DIY hut support not only their own weight, but also that of a living roof of plants above. A pond liner serves as a vapor barrier to keep the interior dry.

Pine-Wood Derby Car



Brad Collette had built a half-dozen Pinewood Derby kit cars with his two Scouting sons when he began to wonder why the boys should have all the fun. "A few of the dads got competitive, so we started an open class with no rules so that we could race, too,"

Collette says. "Anything goes, so long as it's not combustible."

He used CAD software to design a six-part housing that attaches to a conventional 7 x 1 3/4 x 1 3/4-inch pine-wood derby block, then printed it using a MakerBot desktop 3D printer. A spring-loaded triggering mechanism pierces a pair of CO₂ canisters like the firing pins on a double-barreled shotgun, releasing jets of CO₂ that provide outlandish thrust. When Collette set the car loose for its first run, it ripped off 35 feet in 1.6 seconds. A typical derby car makes the run in about 3 seconds.

Problem is, the car doesn't just race, it takes off. Sometimes literally. The jolt from the CO₂ kicks the back wheels loose, he says, and can send the racer rocketing into other cars—or the stands. For next year's dads-only races, Collette is planning a redesign.

Brad Collette posted the CAD files for his CO₂-powered pine-wood derby car, named Bad Idea, online at thingiverse.com.



ELECTRON-GUN SHOW

Ben Krasnow designs fMRI machine components, so he knows about complex electronics. But the most impressive engineering he's pulled off is the scanning electron microscope (SEM) in his garage. "I've never taken on a project like

this before," he says. "I decided I wanted to learn more about particle physics."

Krasnow is a dedicated tinkerer with a talent for getting high-tech parts on the cheap. The electron gun, electronic lenses, electrostatic deflection plates, phosphor screen and photomultiplier he used to create his SEM were all sourced from industrial supply houses and eBay for around \$1500. Since electron microscopy requires a vacuum, a glass bell jar covers the entire apparatus and is sealed to the bottom plate. But once you have your own electron microscope, what do you do with it? Krasnow's SEM has a resolution of about 5 micrometers, roughly one-tenth the diameter of a human hair. He has used the apparatus to look at watch parts, circuit boards and other intricate tiny wonders, and has posted the images on his blog, but he doesn't seem to have any sort of microscopic agenda in mind. "It's not like I really have an application for electron microscopes," he says. "Most of my projects get built, live a couple of months and then get taken apart and made into something else."



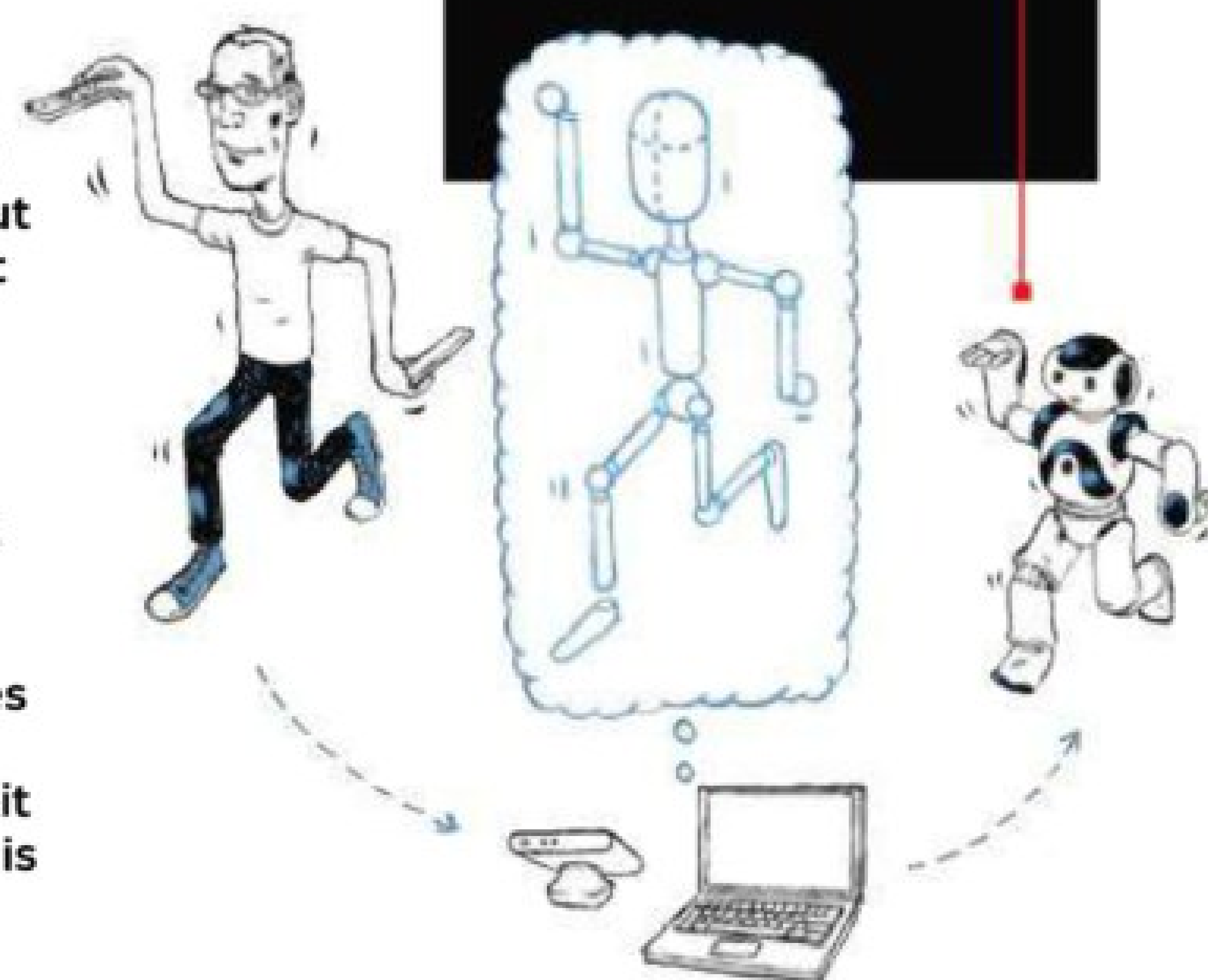
MATT "ZIZZLE" PRATT
Location:
GALLUP, N.M.
Age: 32

BEN KRASNOW
Location:
REDWOOD CITY, CALIF.
Age: 29

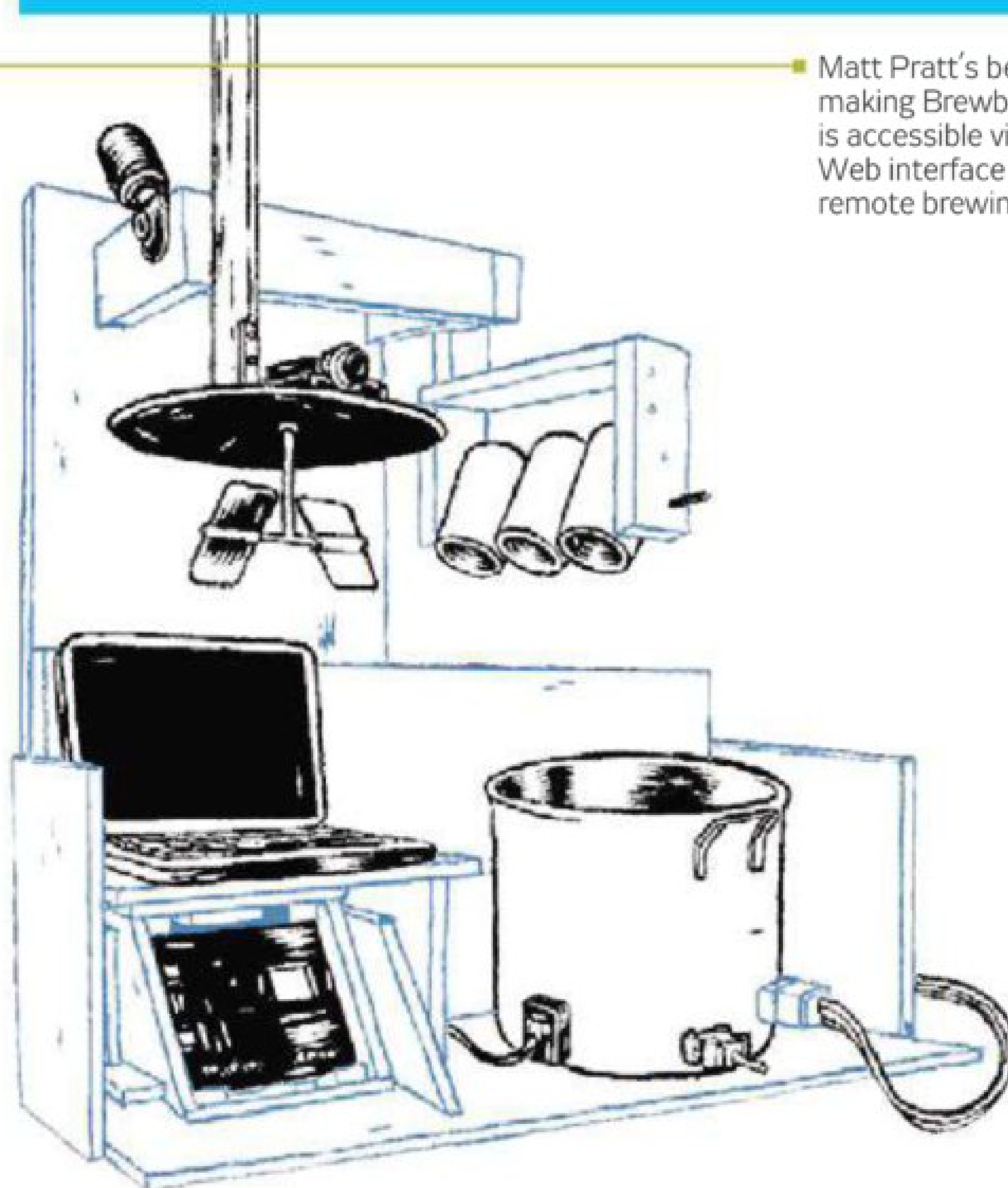
TAYLOR VELTROP
Location: TOKYO Age: 29

WIRELESS MARIONETTES

Sure, Microsoft's Kinect camera array is great for playing *Dance Central* on the Xbox 360, but for robotics hackers like Taylor Veltrop, Kinect is a cheap motion-capture device that offers dizzying DIY possibilities. "When the Kinect came out, I already had the hardware system ready to interface with it," he says. "I just needed to write some software glue to get its skeleton data into my robot's joint data." Veltrop, a Chicago native now living in Tokyo, uses the Kinect's skeleton-tracking capabilities along with two Wii remotes and a laptop to wirelessly animate his Aldebaran and Kondo kit robots with his body movements. The system is impressively accurate—Veltrop's robots can arrange flowers and even cut fruit.



Taylor Veltrop plans to adapt his motion-tracking robots to perform tasks in hazardous environments, such as Japan's irradiated Fukushima Daiichi nuclear plant.



Matt Pratt's beer-making Brewbot is accessible via a Web interface for remote brewing.

stages—and I'd still half-boil something 40 minutes longer than I should have," he says. "I thought, maybe I need a computer to do it."

Soon, Pratt—who goes by the handle Zizzle online—came across the Renesas RX MCU Design Competition, encouraging hackers to incorporate microcontrollers into their DIY projects. So he created Brewbot, an automated machine that imports recipes directly from the open-source Brewtarget application, then fills its kettle, mixes in the grains and maintains temperature and water levels for the mash. "Once, I accidentally sent 12 volts into the system and blew up the Renesas board, but outside of that, the main components worked pretty much straight off the bat," Pratt says. "It makes lots less things we don't want to drink."

Auto-Brewski

Like a lot of Americans, Matt Pratt loves beer. He blogs about it and has studied its

ingredients, so naturally, he took up home brewing. But Pratt hit a few snags: "Using a manual brew process was taking forever. I was setting timers for the different

The EX tricycle has a custom-made frame and chain-drive system, but it is powered by two ordinary 18-volt drill drivers.



SEBASTIAN AURAY,
RUBEN FABER,
NILS FERBER,
LUDOLF VON
OLDERSHAUSEN
Location:
HAMBURG,
GERMANY

DRILL DRIVER

Moving at 20 mph doesn't sound so harrowing—but if you're driving the EX—a tricycle designed by an

obsessive team of students at the University of Fine Arts of Hamburg, Germany—20 mph seems more than fast enough.

Perhaps that's because the EX positions its driver so he's sprawled out on his belly on top of the three-wheeled vehicle, with his face the first point of contact for any oncoming traffic. A specially designed, CNC-milled joint tilts the back wheel to let the rider lean into turns. Modified bicycle parts were used for most of the components—and the trike is powered by nothing but a pair of battery-operated Bosch drill drivers. The 18-volt power tools crank the chain ring in the same direction for maximum, if modest, power; to avoid one drill driver blocking the other, overrunning clutch gearwheels are used to transmit the torque. "The torque you get from a screwdriver is pretty small," Nils Ferber says. "But we wanted the vehicle to look as aggressive and energetic as possible."

The design team drew inspiration, he says, from the skeletal structure of a big cat ready to pounce, though he agrees that this is one skeleton perhaps best left in the closet—or at least the workshop. Fully charged drill drivers poop out after a few minutes, giving the rig a maximum range of about a mile and making it about the least practical electric vehicle ever. But for those few minutes? "It's exciting and fun to drive," Ferber says. "Being that close to the ground and lying on the vehicle headlong, I'm almost glad that I can't go faster than 20 mph."

Scorched-Earth Artwork

Libby, a 7-foot-tall robot, charges across a small backyard in Oakland, Calif., with all the enthusiasm of a household pet—only Libby is capable of spitting flames that could burn down the neighborhood. Such is life at home for Justin Gray, a mechanical whiz who builds electric cars and motorcycles, welds metal sculptures and creates remote-control, fire-breathing robots that he shows off at festivals around the world. "Each of these robots takes on a personality of its own," Gray says. "Libby is a sculpture I did after my dog died, and there's something in there that really personifies my dog's attitude."

The artist says he tries to take a month each year to disappear into his 4000-square-foot machine shop in West Oakland, where he can "just hide from the world and build a robot."

In the ranks of Gray's mobile art, Libby has joined Boris, an elephantine contraption built on the chassis of a trenching machine that lifts its digging chain like a trunk and exhales methanol and propane; Charlie, a robot with a head shaped like that of the creature from *Alien*; and Darwin, an electric track-driven crustacean that packs so much horsepower, the robot can perform track burnouts. "I want to elevate the audience to a level of discomfort and awe," Gray writes on his blog. "When I walk through a gallery, it takes a constant effort to be interested in work hung on the walls. Art to me is alive and breathing down your neck."

Libby the robot is a wirelessly controlled forced-air, multifuel flamethrower on tank treads.



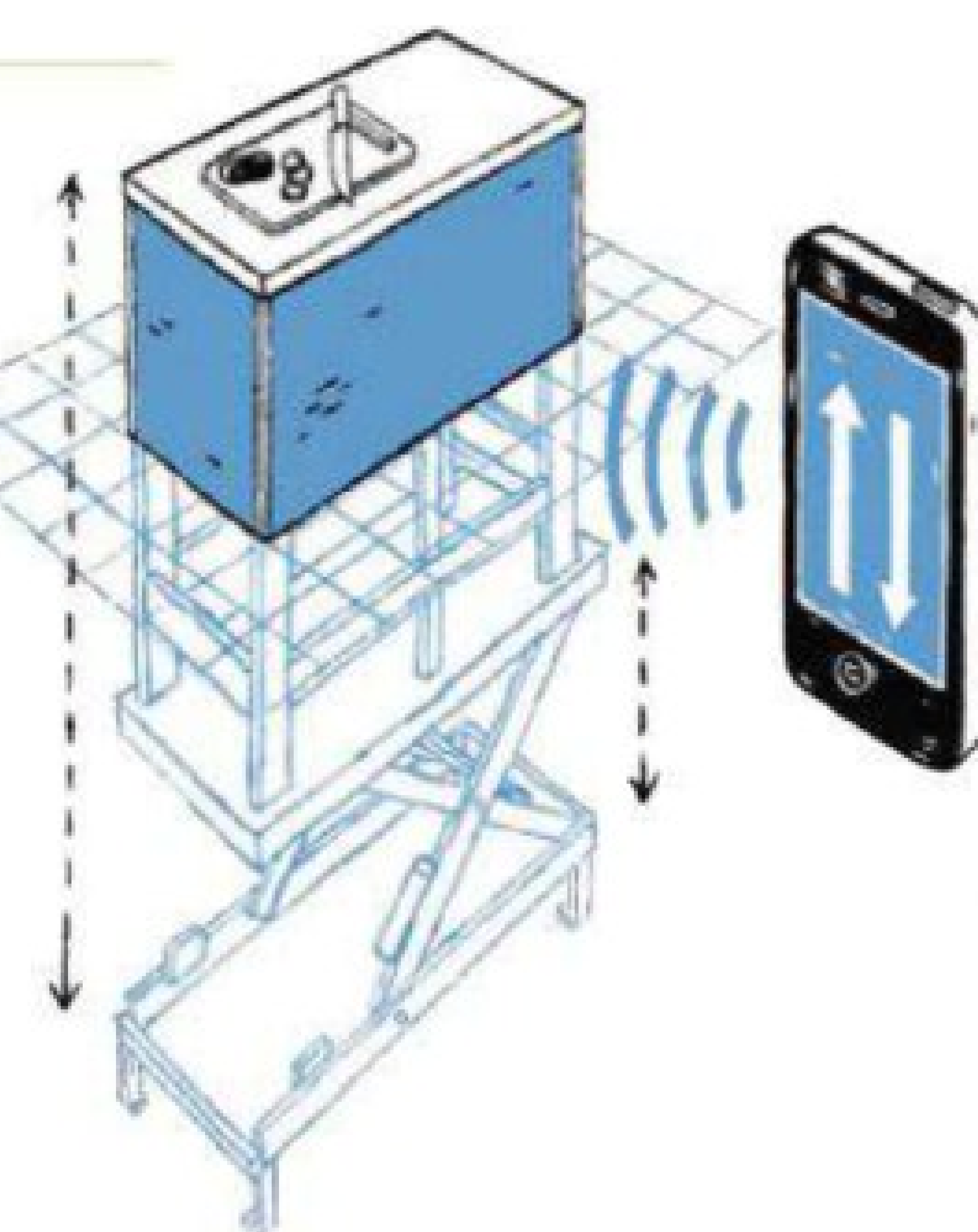
Tim Thaler's hydraulically retractable kitchen island rises from the floor to counter height.



SINKING KITCHEN ISLAND

Soon after moving into his house in Prior Lake, Minn., computer programmer Tim Thaler made renovations most people would never notice. He installed hanging lamps that retract into the bedroom ceiling. He made an RFID-triggered secret door in his basement that leads to his tinkerer's den. In that room he installed his latest home improvement: an iPhone-controlled retractable kitchen island that lifts directly up to the level of the cooking space above. "We wanted to remodel the kitchen, but the new appliances meant less cupboard space," Thaler says, "and a big island made the room feel small."

Thaler bought a hydraulic scissor lift off eBay for a few hundred dollars and bolted it to the



concrete floor. The lift travels only 3 feet—so on top, he constructed a frame from 2 x 4s that brings the island level with the kitchen counters.

Finally, he wired digital switches that hoist the island with the touch of a button. "That was the easy part," he says. "The hard part was telling my wife, 'You're getting a new kitchen! But by the way . . .'" **PM**

TIM THALER
Location: PRIOR LAKE, MINN. Age: 30

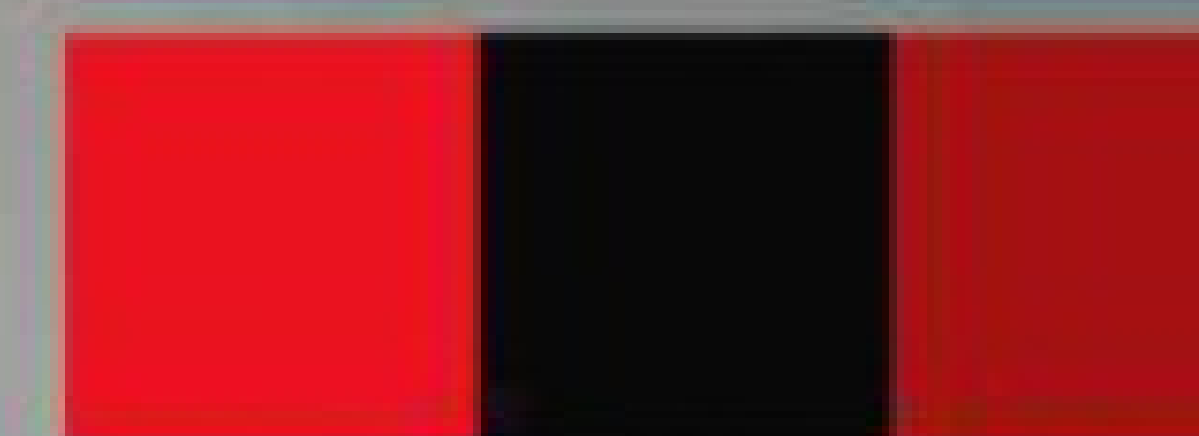
JUSTIN GRAY
Location: OAKLAND, CALIF. Age: 35

THE

light

bulb

wars



by John Herrman
 photograph by Philip Friedman

PAUL BREWER'S PERSPECTIVE on light bulbs is well-illuminated. As the electrical department manager at Solenberger's Hardware in Winchester, Va., Brewer has overseen 34 years of light-bulb buying and selling for the store, witnessing firsthand every modern trend in lighting—and not just through his inventory. Solenberger's Hardware is 6 miles from the site of GE's Winchester Lamp Plant, which the company shuttered in September 2010 after 35 years of operation, citing a "profound transformation" in the lighting business. It was GE's last American plant producing traditional A19 incandescent bulbs.

If the dark plant at 125 Apple Valley Road is a looming icon of the technological and economic changes occurring in the world of household lighting, some subtler cultural side effects are manifesting themselves in the lighting aisle at Solenberger's. "There was a gentleman in here recently," Brewer says. "He bought two cases of incandescent bulbs—240 lights." If this sounds like hoarding, that's because it is. "He's just used to them," Brewer says. "He knows what he likes."

Solenberger's stockpiler isn't paranoid; he's just been reading the news. On Jan. 1, 2012, key provisions of the Energy Independence and Security Act (EISA) of 2007—a sweeping, 300-plus-page energy bill passed by the 110th Congress—will effectively ban the 100-watt incandescent bulb. And this date is only the beginning of a two-year phaseout that will impose new efficiency standards on household lighting. The wording of the EISA technically legislates a bulb's energy usage as it relates to its illumination (i.e., a 1490-lumen, 100-watt-equivalent bulb cannot consume more than 72 watts), but by 2014, that language will

ring a death knell for traditional 75-, 60- and 40-watt incandescent bulbs (barring exemptions for specialty lamps).

What was initially perceived as a mildly controversial step forward for energy efficiency has since faced growing criticism, morphing into a potent symbol of nanny-state interventionism. Politicians are starting to notice, introducing legislative countermeasures at both the state and federal levels. While those antiban bills swirl around in committee, another technology that has been hailed as the next step in lighting for well over two decades is on track for an abrupt coming-of-age. Compact fluorescent lamps (CFLs), enthusiastically touted by industry advocates and environmentalists, are accused by critics of being aesthetically inferior, impractical—and even dangerous. As usual, when technology intersects with political debate, the ratio of rhetoric to science is woefully out of whack.

So POPULAR MECHANICS launched an investigation into the policy and technology of modern lighting. We talked to the experts and advocates on both sides, and tested the various types of bulbs in our labs, all with an eye on the question: What does it take to change a light bulb?

ROLLING BLACKOUT

The lighting-efficiency requirements of the Energy Independence and Security Act of 2007 will start requiring consumers to switch from

traditional incandescent bulbs on Jan. 1, 2012. So which bulbs get phased out, and when?

2012: 100-w equivalent becomes 72 w

2013: 75-w equivalent becomes 53 w

2014: 60-w equivalent becomes 43 w;
 40-w equivalent becomes 29 w



The Brewing Battle

"Why should a select few legislators in 2007 be able to tell hundreds of millions of Americans what light bulbs are best for them?" That's the question posed by Sen. Mike Enzi, R-Wyo., one of the politicians who introduced the Better Use of

Light Bulbs (BULB) Act in late 2010. If passed, the bill would repeal the lighting-efficiency standards outlined in EISA. He's far from alone. The EISA lighting rules were controversial from day one. A Rasmussen poll conducted in 2009 found that 72 percent of Americans were leery of the government's new lighting standards. This is the same percentage of people who support efficiency standards in appliances in a separate Consumer Federation of America study—an odd dichotomy explained, at least in part, by the checkered past of compact fluorescent lighting.

The first commercially available single-piece CFL was the Philips/Norelco SL-18, released to moderate fanfare in the early 1980s. Intended as a screw-in substitute for 100-watt incandescents, the SL-18 promised comparable brightness at just 18 watts, with a life span of 5000 hours. A *POPULAR MECHANICS* 1986 article on CFLs reads as though it was written yesterday: "Despite its spendthrift performance, incandescence remains the illumination of choice for most households... This may be about to change."

It would be a stretch to call the first CFL a runaway success. The lamp took about 3 minutes to reach full brightness and cast a sterile blue light that flickered noticeably. Priced at \$12 (about \$30 adjusted for inflation) and weighing over a pound, the bulb was a tough sell. These downsides were profound enough to blunt sales of the SL-18, along with other early CFL products. Worse, they left a lasting impression.

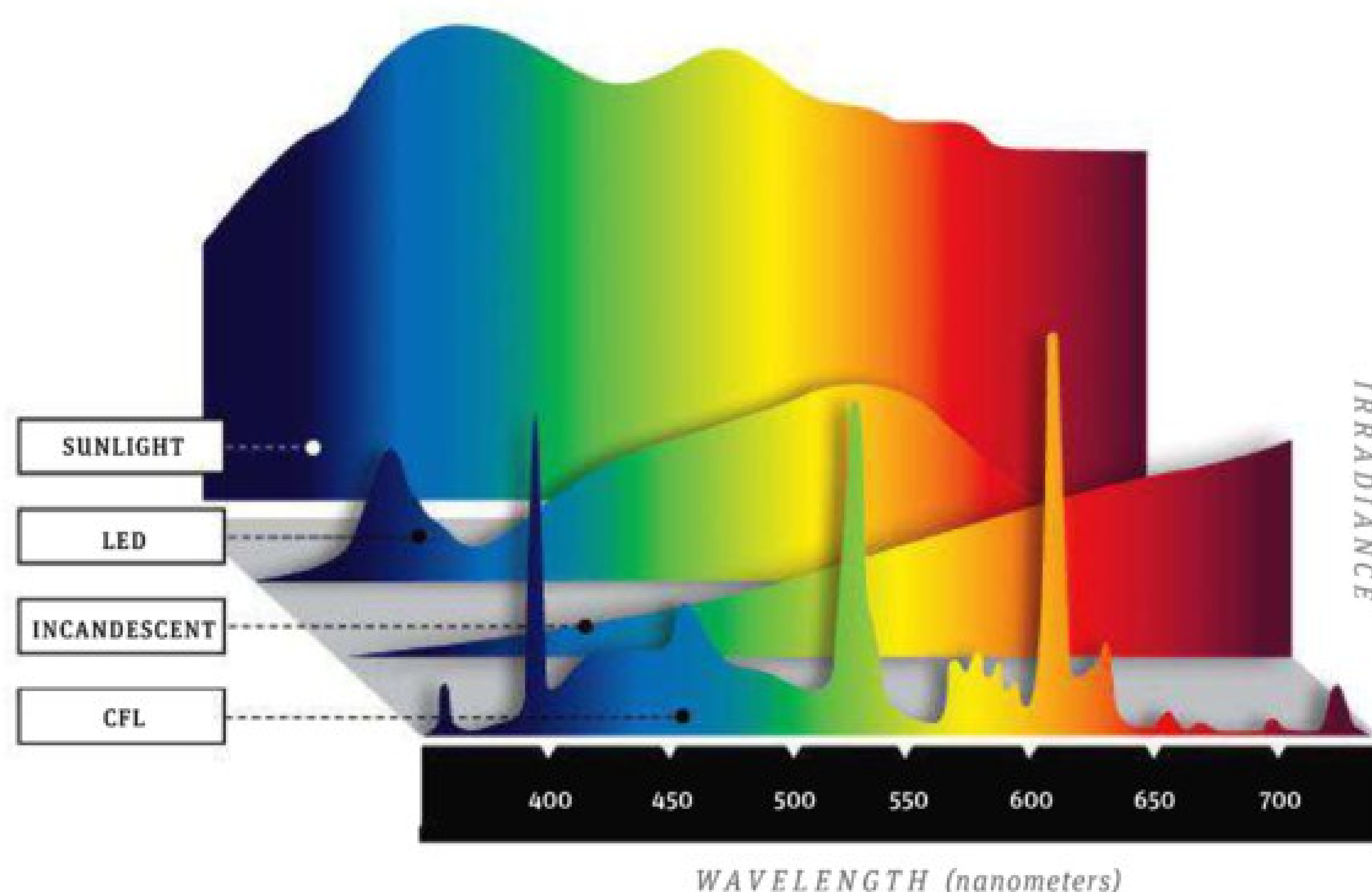
Building a Better Bulb

Modern CFLs bear only a passing resemblance to their early forebears. For one, they're significantly more compact, having shed the outer cases and bulky bases common in early models. Overwhelm-

ingly, they've adopted a spiral bulb shape. The replacement of magnetic ballasts with electric ones has stopped the flickering and reduced overall weight considerably, while advancements in phosphors and glass treatments have given manufacturers finer control over light color. Confront an industry expert about the light quality of CFLs and he will likely issue the Lampshade Dare: Behind two identical screens, it's difficult—even impossible—to tell a CFL from an incandescent.

Most importantly, prices have plummeted. Quality CFLs can be purchased at nearly any hardware store for \$2 or less, a premium over incandescent that can easily be paid back in saved energy costs. Over its 10,000-hour life, a \$2, 14-watt CFL will burn about \$15.40 worth of electricity. Over the same period, a \$0.50, 60-watt

PM LIGHT-BULB TEST



DECODING THE SCIENCE OF LIGHT

The **color temperature** of a light, measured in kelvins, is its most noticeable characteristic. A candle, at 1900 K, appears orange. Daylight, at 5500 K, is much whiter and bluer. A 5500-K bulb, however, will not necessarily produce the same light as the sun; for the full nature of a light source, one must look to its **spectral power distribution (SPD) curve**, which describes its irradiance across the entire visible spectrum. An incandescent bulb achieves its temperature by emitting light over a smooth curve, with the balance tilted toward yellow and red. A CFL, and to a lesser extent an LED, mimics incandescents using a different mixture of light, with spikes and troughs of power strategically positioned across the spectrum to create a *correlated*—or averaged—color temperature. This results in less faithful reproduction of colors, expressed as a diminished **color rendering index (CRI)**.

HOW WE TESTED Readings for color temperature, color rendering and spectral distribution were taken with an Ocean Optics USB2000 Miniature Fiber Optic Spectrometer, provided and calibrated by SpectrEcology of Jasper, Ga. Subjective testing was performed by volunteers in PM's test lab who observed bulbs hidden behind a white shade.

ILLUSTRATIONS BY TYPOZON

incandescent would require \$66 worth of power—and be replaced 10 times.

Yet the reputation persists. It can't have helped that reaching these price and performance levels took three decades, during which time perceived—and actual—shortcomings of CFLs became an inextricable part of their identity. Dave Geraci, CFL product manager for bulb manufacturer TCP, explains, "Once this stuff is ingrained in people's minds, it's not going to change."

The perception of the CFL as a flawed technology has allowed some pernicious ideas to take hold: that mercury contained in CFLs offsets their environmental advantage (generated by coal, the power required by a less-efficient incandescent bulb would result in a greater release of mercury into the environment than an

improperly disposed-of CFL); that the bulbs are dangerous when broken (if government or manufacturer disposal guidelines are followed, they are not likely to cause harm); and that they produce poor-quality light compared with incandescent bulbs (while our lab testing confirmed objective differences in the bulbs' light, surveyed testers' preferences were divided among bulb types). These beliefs have proved resilient, which is unfortunate not just because they're misguided, but because they draw attention away from better-founded concerns. That is to say: CFLs aren't as bad as you may have heard. But they're not perfect, either.

INCANDESCENT BULBS

An incandescent bulb emits light by heating a tungsten filament surrounded by various inert gases to about 4000 F. These bulbs light well and cost little, but die quickly and are highly inefficient, releasing 90 percent of their energy as heat. In incandescent bulbs, PM's testers noted yellow hues and warm light.



Name	PHILIPS SOFT WHITE	GE SOFT WHITE	GE CLEAR	GE REVEAL
Price range	\$0.32–\$1.44	\$0.57–\$0.94	\$1.16–\$1.95	\$0.72–\$2.09
Wattage	60 w	60 w	60 w	60 w
Brightness (lumens)	860 lm	780 lm	750 lm	630 lm
Life span	1000 hr	2000 hr	1000 hr	1000 hr
Energy cost/1000 hours	\$6.60	\$6.60	\$6.60	\$6.60
Color temperature reported/tested (kelvins)	2700 K/2782 K	2700 K/2626 K	2700 K/2691 K	2800 K/2598 K
CRI	99.7	99.4	99.3	79.7
Spectral power distribution curve				
Test-group comments	"Rich color," "warm," "soft," "dull."	"Yellow," "warm," "warmer," "greenish skin hue," "slightly dirty."	"White," "pleasing," "good intensity," "harsh shadows," "clean."	"Rich," "slightly orange," "warm," "pinkish," "good for reading."
Overall rating	Good	Good	Excellent	Excellent

CFL and LED Test Results



Behind the Curve

Michael Siminovitch, director of the California Lighting Technology Center at the University of California, Davis, and a supporter of CFL adoption, says that the technology earned its reputation: “Incandescent lights have well-

defined performance and expectations. CFLs are a departure.” Years of focus on reducing cost and maximizing efficiency, he says, relegated concerns such as light color, reliability and startup time to secondary importance. The product suffered, and by extension, so did its users.

Today, the gap between expectation and experience still exists in the world of CFLs. Studies by the Program for the Evaluation and Analysis of Residential Lighting (PEARL) trade group have shown that CFLs don’t always live up to manufacturers’ claims, particularly in life span. TCP’s Dave Geraci agrees: “There are still a few out there—quite popular brands, actually—that will fail early.”

Other issues persist, none of which are fatal, but all of which are notable. CFLs

achieve full brightness faster than ever before, but this can still take up to 60 seconds. Dimming functionality usually requires specific bulbs and entirely new lighting fixtures and, in the end, produces a less appealing cool light at low brightness. (When an incandescent

COMPACT FLUORESCENT LAMPS

Inside a CFL, an electric current is driven through a tube filled with argon and a small amount of mercury vapor. This creates invisible UV light, which excites a phosphor coating that reacts by emitting visible light. CFLs are efficient and long-lasting, but take time to warm up. With CFLs, PM’s testers noted inconsistent light qualities.



Name	GE ENERGY SMART SOFT WHITE	ECOSMART DAYLIGHT	ECOSMART SOFT WHITE	PHILIPS ENERGY SAVER SOFT WHITE	GE ENERGY SMART WARM SOFT WHITE	ECOSMART TRUE COLOR
Price	\$0.87–\$3.00	\$1.99–\$3.97	\$2.40–\$3.90	\$3.32–\$9.99	\$5.22–\$7.01	\$5.97
Wattage	13 w	14 w	14 w	14 w	15 w	14 w
Brightness	870 lm	800 lm	900 lm	800 lm	800 lm	650 lm
Life span	6000 hr	10,000 hr	10,000 hr	8000 hr	8000 hr	10,000 hr
\$/1000 hr	\$1.43	\$1.54	\$1.54	\$1.54	\$1.65	\$1.54
Temp	2700 K/2695 K	5000 K/4965 K	2700 K/2783 K	2700 K/2616 K	2700 K/2701 K	5500 K/5377 K
CRI	84.9	86.9	84.7	84.3	83.9	88.8
SPD curve						
Test-group comments	“Yellowish,” “harsh,” “slow starter,” “warms nicely.”	“Cold,” “much too cool,” “perfect white,” “awesome color,” “a bit dim.”	“Natural color,” “soft shadows,” “too yellow,” “yellow cast.”	“Colors pop,” “purple,” “not great on skin,” “slow warmup.”	“White tone,” “too white,” “soft green.”	“Accurate colors,” “very white,” “pleasing intensity,” “natural.”
Rating	Fair	Good	Good	Good	Good	Excellent

bulb is dimmed, its light gets warmer and redder; when a CFL dims, its color stays the same.) POPULAR MECHANICS' testing also revealed deep differences in the spectral power distribution of CFLs and incandescents. Rather than following a smooth curve, fluorescent light shows severe peaks and troughs of power throughout the spectrum. The light of CFLs is a result of engineering, calculation and compromise. It's different both objectively and subjectively: Some testers noted that CFLs produce a sickly skin tone, cast greenish hues or simply *feel* fluorescent.

The end result, which CFL supporters are hesitant to acknowledge, is that to use CFLs is to accept a real, material change in your relationship with lighting. Bulbs won't flick on like you're used to; the initial cost of bulbs is slightly higher; and the

performance from brand to brand is nowhere near as consistent as it is with incandescents. Switching to CFLs requires effort; sticking with incandescents does not.

Topping it all off is anxiety about safety. Crushing a bulb won't create a mercury-contaminated Superfund site—Rensselaer Polytechnic Institute Lighting Research Center senior research scientist John Bullough famously said, "You [just] don't want to run over and sniff it up"—but cleaning up a broken CFL is undeniably more involved than sweeping up a shattered incandescent. The mere existence of a new protocol can seem strange: Since

LIGHT-EMITTING-DIODE LAMPS

LEDs are composed of two conjoined sections of a semiconductor material. When an LED is energized, movement of electrons across the diode causes emission of photons—or light. LED lamps are efficient, produce little heat and have extremely long life spans, but are costly. In LEDs, PM's testers noted pleasing light but a lack of power.



				
ECOSMART BRIGHT WHITE	PIXI	PHILIPS ENDURALED	PHILIPS AMBIENTLED	GE ENERGY SMART
\$17.97–\$21.95	\$18.00	\$26.31–\$35.00	\$39.99	\$39.99–\$49.53
9 w	8.5 w	8 w	12.5 w	9 w
429 lm	455 lm	450 lm	800 lm	450 lm
50,000 hr	25,000 hr	25,000 hr	25,000 hr	25,000 hr
\$0.99	\$0.93	\$0.88	\$1.38	\$0.99
3000 K/3061 K	3000 K/2653 K	2700 K/2604 K	2700 K/2643 K	3000 K/2982 K
90	90.4	80.4	81.4	80.9
				
"Directed upward," "good diffusion," "nice color," "too dim," "dingy."	"Pinkish," "queasy," "good brightness," "bad skin tone."	"Familiar," "warm," "pink," "yellowish," "harsh shadows."	"Warm," "yellow," "relaxing hue," "pleasant."	"True blues," "balanced," "good diffusion," "good on skin."
Good	Fair	Fair	Good	Excellent

when is a broken light bulb something to worry about?

And CFLs require special disposal techniques. Nothing crazy—just recycling at approved waste facilities or chain stores like Home Depot and Ikea. But municipal and state authorities have done a poor job of publicizing options where they exist and creating them where they don't. "It's important that the infrastructure is in place," says Jeffrey Harris of the Alliance to Save Energy. "We're going to need to step up our game."

It's not that these problems are catastrophic for the CFL. It's that consumers are put off by any level of inconvenience, uncertainty and disappointment in a product they're accustomed to taking for granted. These are still just light bulbs, after all.

A Temporary Solution

Assuming EISA's lighting rules have their intended effect, compact fluorescent bulbs will account for a majority of light bulbs sold in the United States, serving alongside the select halogen incandescent bulbs that meet the updated efficiency requirements. This hard-earned era of dominance, however, may be short-lived.

The LED sector is white-hot, attracting attention from the lighting industry's traditional leaders as well as nimble startups, backed by venture capital

firms with a history of high-tech investment. One such startup is San Jose, Calif.-based Switch Lighting. The company's lamp has a conspicuous aluminum substructure, which draws heat away from a circular cluster of 10 tiny diodes with metallic protrusions, giving it a weapon-like quality. As an object, it's muscular and industrial. Above all, it's strange.

LEDs are at least as efficient as CFLs, are mercury-free, have no startup delay and are easier to tune for color. They can function with existing dimmers. Their life spans are measured in decades, and they have already proved successful for applications in flashlights, desk lamps and household accent lighting. When Switch's 60-, 75- and 100-watt-equivalent lamps hit stores, they'll be competing against LEDs from the likes of GE and Philips for what industry insiders agree, often begrudgingly, is the future of lighting.

That's not to say LEDs are ready competitors to CFLs. There are few lamps on the market, and almost none are 100-plus-watt equivalents. Then there is the price: In the world of LEDs, \$20 is a bargain. Fifty dollars is the norm.

Everyone agrees: The price will come down. The question is, when? Brett Sharenow of Switch is predictably optimistic: "I actually think we'll be able to buy a 40-watt-equivalent LED for under \$10 in less than two years." Gary Trott of Cree LED Lighting Solutions believes his company's LEDs have already reached a turning point with consumers. "I can't predict where the price is going to be, but I can say that a year from now, it's going to be a lot lower," he says. Nobody is sure how long it will take LEDs to truly dominate the market—the most bullish estimates see widespread adoption before 2015, while more sober evaluations have it creeping well past 2020—but few doubt it will happen.

Why Wait?

In the Energy Independence and Security Act, Nicolas Loris of the Heritage Foundation sees a parallel to the government's subsidization of ethanol-based fuel tech, which he argues redirects investment toward stopgap solutions. "When the government gets involved in these decisions, they crowd out other ideas." Besides, he says, "we think consumers will make the right decisions themselves, because they want to save money." Brett Sharenow doesn't see a problem: "We don't care what the government does. [As LED manufacturers], it's completely moot to us."

Whether the EISA rules achieve their goals remains to be seen. In one way, however, they have already been a failure. The perception of the ban as a regulatory overreach has merit: It does more than encourage lower energy use; it limits

choice in situations where incandescent bulbs might be preferable. Worse, the passionate political backlash inspired by the rules continues to do lasting damage to the reputation of a genuinely good technology, amplifying the shortcomings of CFLs to the point of distortion. In the end, consumers are best served by ignoring the rhetoric and trying new bulbs for themselves. And while an open mind will find a lot to like in the alien lighting aisle of 2011, don't worry if you feel the lingering urge to stockpile a box or two of those old-style bulbs—just in case. **PM**

HOW BULBS DIE

Incandescent: Operating at several thousand degrees Fahrenheit, the tungsten filament—up to 6.5 feet long—evaporates over time. Eventually, it breaks apart because of wear or uneven heat distribution—often popping in a "burnout arc."

CFL: In most cases, the emissive coating on the bulb's cathodes is diminished, or sputtered off, and the bulb simply goes out. If the bulb's ballast fails first, its electronics can overheat, causing audible crackles and sometimes melting the bulb's plastic base. It may appear dangerous, but don't worry—CFLs are designed to fail this way.

LED: Over time, the semiconductor materials lose their capacity to transfer electrons, resulting in a gradual loss of brightness.



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DRILLING DOWN: FACT VS FICTION IN THE GREAT

FRACKING DEBATE

BY SEAMUS MCGRAW

MODELS AND MAP BY MEGAN CAPONETTO

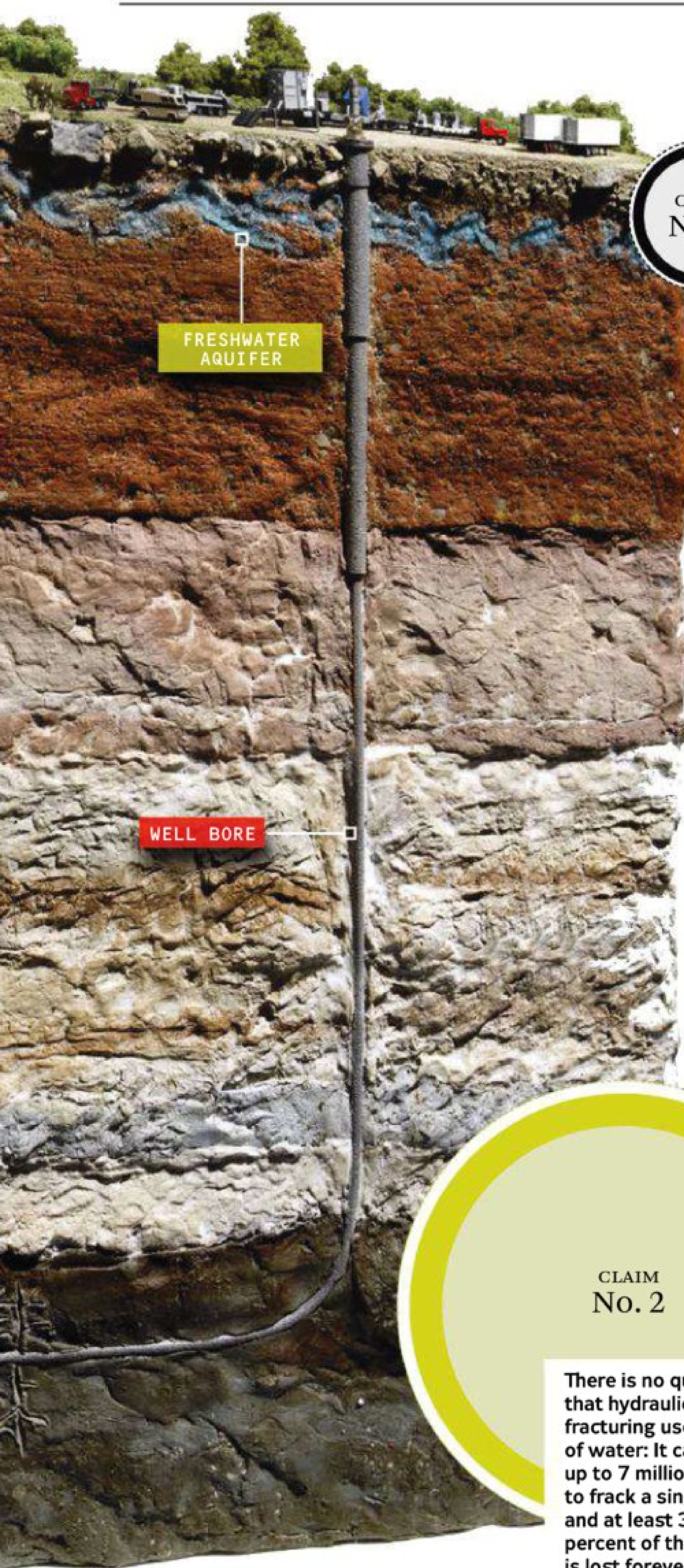
PHOTOGRAPHS BY TOM SCHIERLITZ

HORIZONTAL
DRILLING

FRACTURED SHALE FORMATION

Thousands of feet beneath rural Pennsylvania and its freshwater aquifers, dogleg drilling and hydraulic pressure combine to fracture the Marcellus Shale and siphon its vast natural gas reserves. But the techniques raise environmental concerns.

MODEL NOT TO SCALE



CLAIM
No. 1

“WE ARE THE SAUDI ARABIA OF
NATURAL GAS.”

SEN. JOHN KERRY, D-MASS., MAY 2010

Less than a decade ago, industry analysts and government officials fretted that the United States was in danger of running out of gas. No more. Over the past several years, vast caches of natural gas trapped in deeply buried rock have been made accessible by advances in two key technologies: horizontal drilling, which allows vertical wells to turn and snake more than a mile sideways through the earth, and hydraulic fracturing, or fracking. Developed more than 60 years ago, fracking involves pumping millions of gallons of chemically treated water into deep shale formations at pressures of 9000 pounds per square inch or more. This fluid cracks the shale or widens existing cracks, freeing hydrocarbons to flow toward the well.

These advances have led to an eightfold increase in shale gas production over the past decade. According to the Energy Information Administration, shale gas will account for nearly half of the natural gas produced in the U.S. by 2035. But the bonanza is not without controversy, and nowhere, perhaps, has the dispute over fracking grown more heated than in the vicinity of the Marcellus Shale. According to Terry Engelder, a professor of geosciences at Penn State, the vast formation sprawling primarily beneath West Virginia, Pennsylvania and New York could produce an estimated 493 trillion cubic feet of gas over its 50- to 100-year life span. That's nowhere close to Saudi Arabia's total energy reserves, but it is enough to power every natural gas-burning device in the country for more than 20 years. The debate over the Marcellus Shale will shape national energy policy—including how fully, and at what cost, we exploit this vast resource.

CLAIM
No. 2

“HYDRAULIC FRACTURING
SQUANDERS OUR PRECIOUS
WATER RESOURCES.”

Green Party of Pennsylvania, April 2011

There is no question that hydraulic fracturing uses a lot of water: It can take up to 7 million gallons to frack a single well, and at least 30 percent of that water is lost forever, after being trapped deep in the shale. And while there is some evidence that fracking has contributed to the depletion of water supplies in drought-

stricken Texas, a study by Carnegie Mellon University indicates the Marcellus region has plenty of water and, in most cases, an adequate system to regulate its usage. The amount of water required to drill all 2916 of the Marcellus wells permitted in Pennsylvania in the first 11 months of 2010 would equal the

amount of drinking water used by just one city, Pittsburgh, during the same period, says environmental engineering professor Jeanne VanBriesen, the study's lead author. Plus, she notes, water withdrawals of this new industry are taking the place of water once used by industries, like steel manufacturing, that

the state has lost. Hydrogeologist David Yoxtheimer of Penn State's Marcellus Center for Outreach and Research gives the withdrawals more context: Of the 9.5 billion gallons of water used daily in Pennsylvania, natural gas development consumes 1.9 million gallons a day (mgd); livestock use 62 mgd; mining, 96 mgd; and industry, 770 mgd.

CLAIM
No. 3

NATURAL GAS IS CLEANER, CHEAPER, DOMESTIC, AND IT'S VIABLE NOW.

OILMAN TURNED NATURAL-GAS CHEERLEADER T. BOONE PICKENS, SEPTEMBER 2009

Burning natural gas is cleaner than oil or gasoline, and it emits half as much carbon dioxide, less than one-third the nitrogen oxides, and 1 percent as much sulfur oxides as coal combustion. But not all shale gas makes it to the fuel tank or power plant. The methane that escapes during the drilling process, and later as the fuel is shipped via pipelines, is a significant greenhouse gas. At least one scientist, Robert Howarth at Cornell University, has calculated that methane losses could be as high as 8 percent. Industry officials concede that they could be losing anywhere between 1 and 3 percent. Some of those leaks can be prevented by aggressively sealing condensers, pipelines and wellheads. But there's another upstream factor to consider: Drilling is an energy-intensive business. It relies on diesel engines and generators running around the clock to power rigs, and heavy trucks making hundreds of trips to drill sites before a well is completed. Those in the industry say there's a solution at hand to lower emissions—using natural gas itself to power the process. So far, however, few companies have done that.



BULLISH ON
OILFIELDS,
THEN WIND
FARMS,
BILLIONAIRE
ENERGY
INVESTOR
T. BOONE
PICKENS NOW
PROMOTES
NATURAL GAS
AS THE FUEL
OF CHOICE
FOR HEAVY
TRUCKS.

CLAIM
No. 4

[THERE'S] NEVER BEEN ONE CASE—DOCUMENTED CASE—OF GROUNDWATER CONTAMINATION IN THE HISTORY OF THE THOUSANDS AND THOUSANDS OF HYDRAULIC FRACTURING [WELLS].

SEN. JAMES INHOFE, R-OKLA., APRIL 2011

The senator is incorrect. In the past two years alone, a series of surface spills, including two blowouts at wells operated by Chesapeake Energy and EOG Resources and a spill of 8000 gallons of fracking fluid at a site in Dimock, Pa., have contaminated groundwater in the Marcellus Shale region. But the idea stressed by fracking critics that deep-injected fluids will migrate into groundwater is

mostly false. Basic geology prevents such contamination from starting below ground. A fracture caused by the drilling process would have to extend through the several thousand feet of rock that separate deep shale gas deposits from freshwater aquifers. According to geologist Gary Lash of the State University of New York at Fredonia, the intervening layers of rock have distinct mechanical properties that would

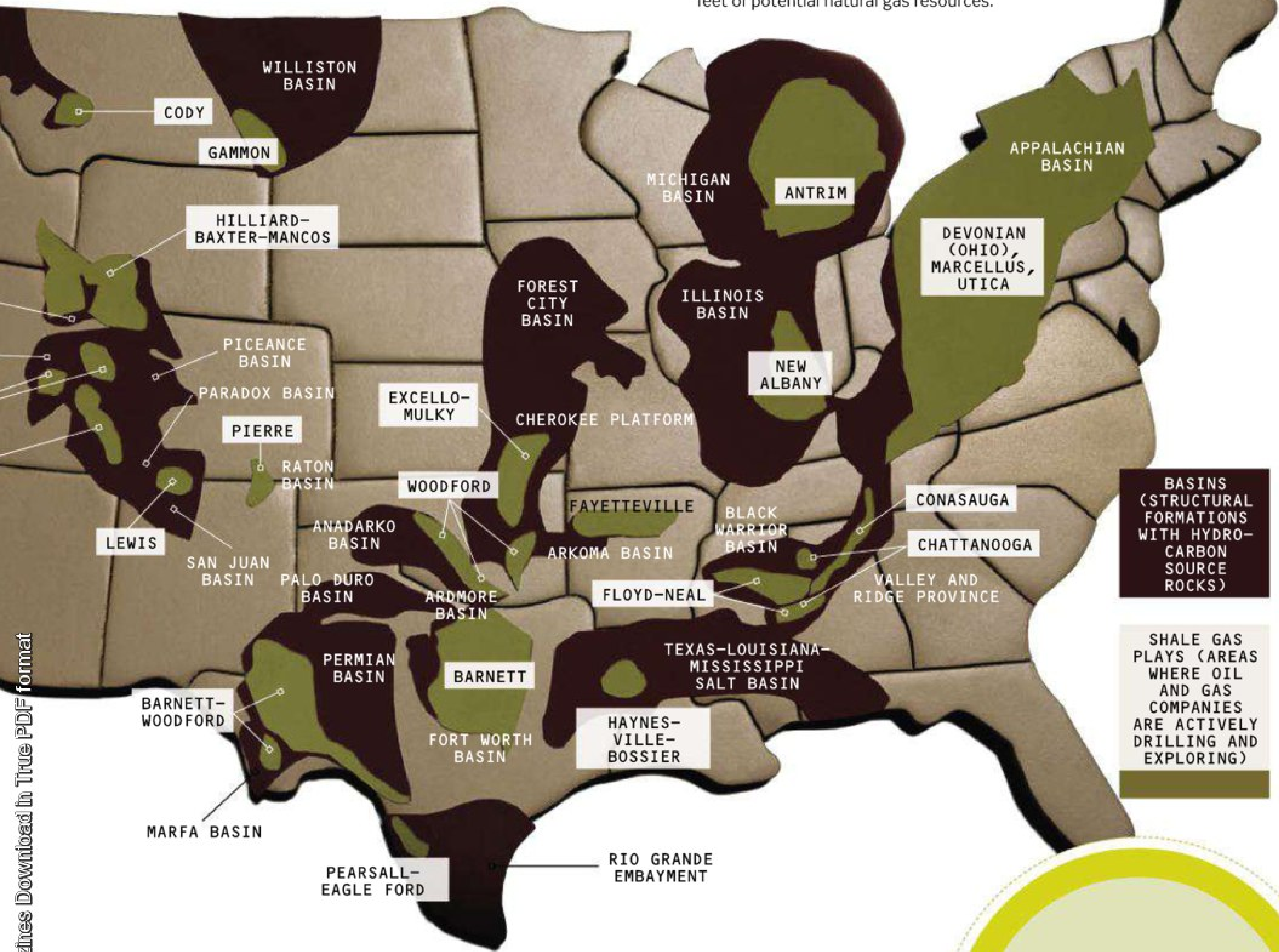
prevent the fissures from expanding a mile or more toward the surface. It would be like stacking a dozen bricks on top of each other, he says, and expecting a crack in the bottom brick to extend all the way to the top one. What's more, the fracking fluid itself, thickened with additives, is too dense to ascend upward through such a channel. EPA officials are closely watching one place for evidence otherwise: tiny Pavillion, Wyo., a

remote town of 160 where high levels of chemicals linked to fracking have been found in groundwater supplies. Pavillion's aquifer sits several hundred feet above the gas cache, far closer than aquifers atop other gas fields. If the investigation documents the first case of fracking fluid seeping into groundwater directly from gas wells, drillers may be forced to abandon shallow deposits—which wouldn't affect Marcellus wells.

MATT NAGER/THE NEW YORK TIMES/REDUX (T. BOONE PICKENS)

SHALE GAS NATION

The Energy Information Administration estimates the U.S. has 2552 trillion cubic feet of potential natural gas resources.



CLAIM
No. 5

“THE GAS ERA IS COMING, AND THE LANDSCAPE NORTH AND WEST OF [NEW YORK CITY] WILL INEVITABLY BE TRANSFORMED AS A RESULT. WHEN THE VALVES START OPENING NEXT YEAR, A LOT OF POOR FARM FOLK MAY BECOME TEXAS RICH. AND A LOT OF OTHER PEOPLE—ESPECIALLY THE ECOSENSITIVE NEW YORK CITY CROWD THAT HAS SETTLED AMONG THEM—WILL BE APOPLECTIC AS THEIR PRISTINE WEEKEND SANCTUARY IS CONVERTED INTO AN INDUSTRIAL ZONE, CRISSCROSSED WITH DRILL PADS, PIPELINES, AND ACCESS ROADS.”

New York magazine, Sept. 21, 2008

Much of the political opposition to fracking has focused on the Catskill region, headwaters of the Delaware River and the source of most of New York City's drinking water. But the expected boom

never happened—there's not enough gas in the watershed to make drilling worthwhile. “No one has to get excited about contaminated New York City drinking water,” Penn State's Engelder told

the *Times Herald-Record* of Middletown, N.Y., in April. The shale is so close to the surface that it's not concentrated in large enough quantities to make recovering it economically

feasible. But just to the west, natural gas development is dramatically changing the landscape. Drilling rigs are running around the clock in western Pennsylvania. Though buoyed by the

economic windfall, residents fear that regulators can't keep up with the pace of development. “It's going to be hard to freeze-frame and say, ‘Let's slow down,’” Sen. Robert P. Casey Jr., D-Pa., said last

fall. “That makes it more difficult for folks like us, who say we want to create the jobs and opportunity in the new industry, but we don't want to do it at the expense of water quality and quality of life.”

“NATURAL GAS IS AFFORDABLE, ABUNDANT AND AMERICAN. IT COSTS ONE-THIRD LESS TO FILL UP WITH NATURAL GAS THAN TRADITIONAL GASOLINE.”

REP. JOHN LARSON, D-CONN., CO-SPONSOR OF H.R. 1380, A MEASURE THAT WOULD PROVIDE TAX INCENTIVES FOR THE DEVELOPMENT AND PURCHASE OF NATURAL GAS VEHICLES, MARCH 2011

That may be true. Plus, there's another incentive: Vehicles powered by liquefied natural gas, propane or compressed natural gas run cleaner than cars with either gasoline or diesel in the tank. According to the Department of Energy, if the transportation sector

switched to natural gas, it would cut the nation's carbon-monoxide emissions by at least 90 percent, carbon-dioxide emissions by 25 and nitrogen-oxide emissions by up to 60. But it's not realistic: Nationwide, there are only about 3500 service stations (out of

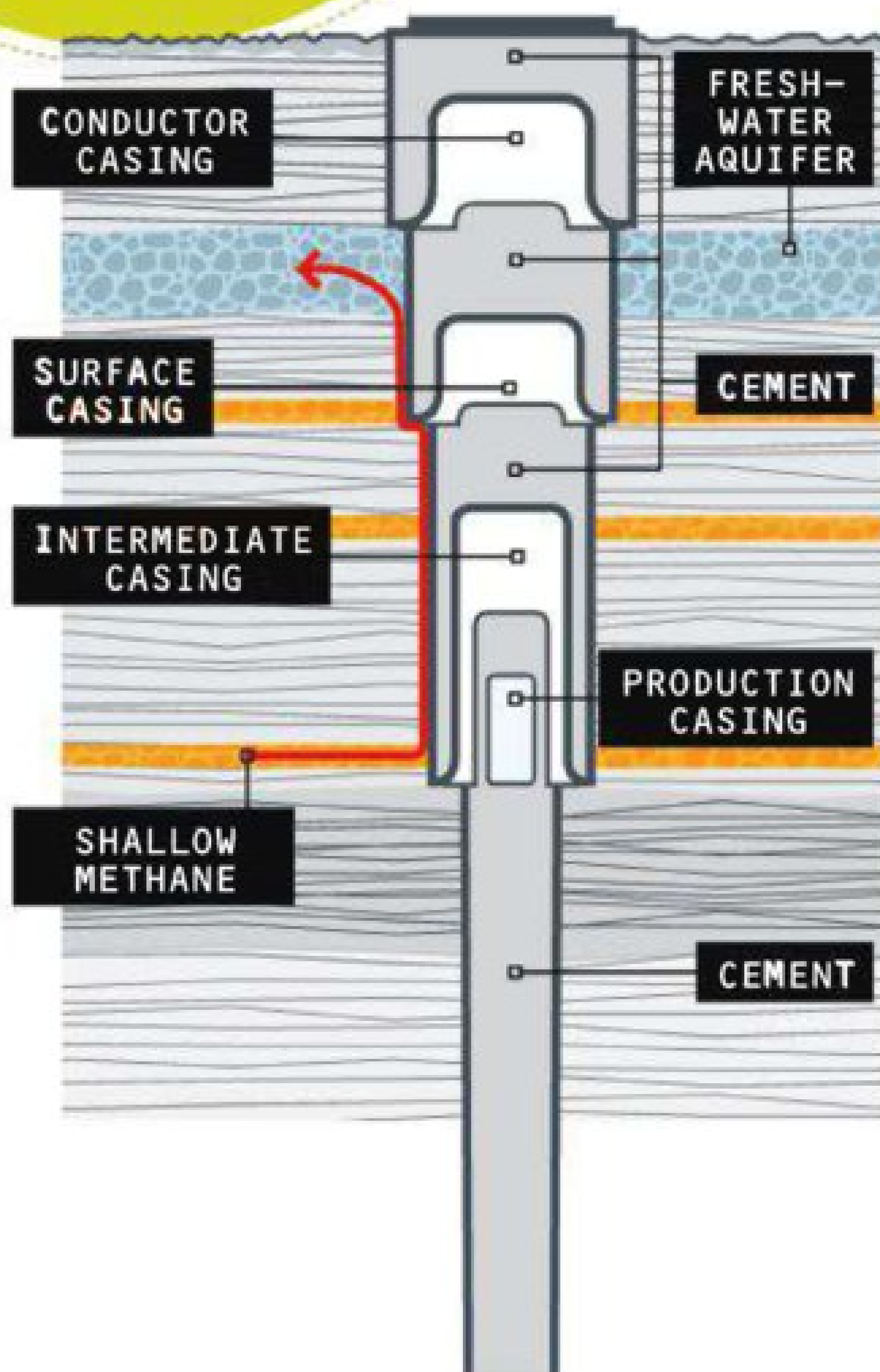
120,000) that offer natural gas-based automotive fuel, and it would cost billions of dollars and take years to develop sufficient infrastructure to make that fuel competitive with gasoline or diesel. And only Honda makes a car that can run on natural gas. That

doesn't mean natural gas has no role in meeting the nation's short-term transportation needs. In fact, buses in several cities now rely on it, getting around the lack of widespread refueling opportunities by returning to a central terminal for a fill-up. The same could be

done for local truck fleets. But perhaps the biggest contribution natural gas could make to America's transportation picture would be more indirect—as a fuel for electric-generation plants that will power the increasingly popular plug-in hybrid vehicles.

“DO NOT DRINK THIS WATER”

HANDWRITTEN SIGN IN THE DOCUMENTARY GASLAND, 2010

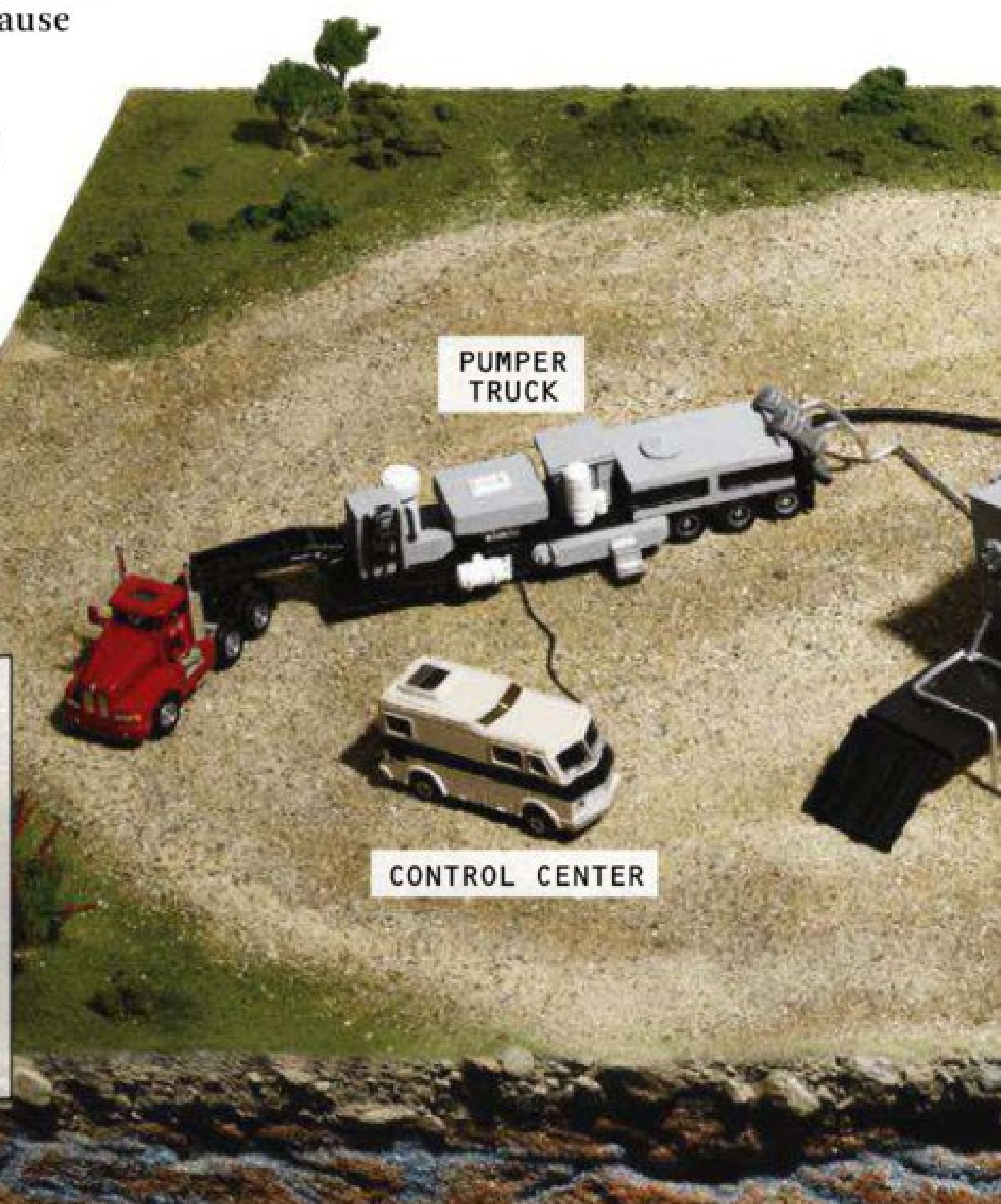


It's an iconic image, captured in the 2010 Academy Award-nominated documentary *GasLand*. A Colorado man holds a flame to his kitchen faucet and turns on the water. The pipes rattle and hiss, and suddenly a ball of fire erupts. It appears a damning indictment of the gas drilling nearby. But Colorado officials determined the gas wells weren't to blame; instead, the homeowner's own water well had been drilled into a naturally occurring pocket of methane. Nonetheless, up to 50 layers of natural gas can occur between the surface and deep shale formations, and methane from these shallow deposits *has* intruded on groundwater near fracking sites. In May, Pennsylvania officials fined Chesapeake Energy \$1 million for contaminating the water supplies of 16 families in Bradford County. Because the company had not properly cemented its boreholes, gas migrated up along the outside of the well, between the rock and steel casing, into aquifers. The problem can be corrected by using stronger cement and processing casings to create a better bond, ensuring an impermeable seal.

ILLUSTRATION BY DOGO

SURFACE OPERATIONS

At the blender, fracking chemicals and proppant—particulates like sand that hold open fractures in the shale—are added to pure or recycled water from fluid storage tanks. This slurry is transferred through the manifold to pumpers, which boost the pressure. The manifold then directs it into a high-pressure line leading to the well. When the liquid returns to the surface after fracking, it's stored in a lined wastewater pond for treatment or recycling. Multiply each truck in this model by 10 and the storage tanks by 50 and you begin to approach the scale of a natural gas operation.



CLAIM
No. 8

“AS NEW YORK
GEARS UP
FOR A MASSIVE
EXPANSION OF GAS DRILLING
IN THE MARCELLUS SHALE,
STATE OFFICIALS HAVE MADE
A POTENTIALLY TROUBLING
DISCOVERY ABOUT THE
WASTEWATER CREATED BY THE
PROCESS: IT'S RADIOACTIVE.”

ProPublica, November 2009

Shale has a radioactive signature—from uranium isotopes such as radium-226 and radium-228—that geologists and drillers often measure to chart the vast underground formations. The higher the radiation levels, the greater the likelihood those deposits will yield significant amounts of gas. But that does not necessarily mean the radioactivity poses a public health hazard; after all, some homes in Pennsylvania and New York have been built directly on Marcellus shale. Tests conducted earlier this year in Pennsylvania waterways that had received treated water—both produced water (the fracking fluid that returns to the surface) and brine (naturally occurring water that contains radioactive elements, as well as other toxins and heavy metals from the shale)—found no evidence of elevated radiation levels. Conrad Dan Volz, former scientific director of the Center for Healthy Environments and Communities at the University of Pittsburgh, is a vocal critic of the speed with which the Marcellus is being developed—but even he says that radioactivity is probably one of the least pressing issues. “If I were to bet on this, I’d bet that it’s not going to be a problem,” he says.

CLAIM
No. 9

“CLAIMING THAT THE INFORMATION IS PROPRIETARY,
DRILLING COMPANIES HAVE STILL NOT COME OUT AND
FULLY DISCLOSED WHAT FRACKING FLUID IS MADE OF.”

Vanity Fair, June 2010

Under mounting pressure, companies such as Schlumberger and Range Resources have posted the chemical compounds used in some of their wells, and in June, Texas became the first state to pass a law requiring full public disclosure. This greater transparency has revealed some oddly benign ingredients, such as instant coffee and walnut shells—but also some known and suspected carcinogens, including benzene and methanol. Even if these chemicals can be found under kitchen sinks, as industry points out, they’re poured down wells in much greater volumes: about 5000

gallons of additives for every 1 million gallons of water and sand. A more pressing question is what to do with this fluid once it rises back to the surface. In Texas’s Barnett Shale, wastewater can be reinjected into impermeable rock 1.5 miles below ground. This isn’t feasible in the Marcellus Shale region; the underlying rocks are not porous enough. Currently, a handful of facilities in Pennsylvania are approved to treat the wastewater. More plants, purpose-built for the task, are planned. In the meantime, most companies now recycle this water to drill their next well.

CLAIM
No. 10

“THE INCREASING ABUNDANCE OF CHEAP
NATURAL GAS, COUPLED WITH RISING
DEMAND FOR THE FUEL FROM CHINA AND THE FALL-OUT
FROM THE FUKUSHIMA NUCLEAR DISASTER IN JAPAN, MAY
HAVE SET THE STAGE FOR A ‘GOLDEN AGE OF GAS.’”

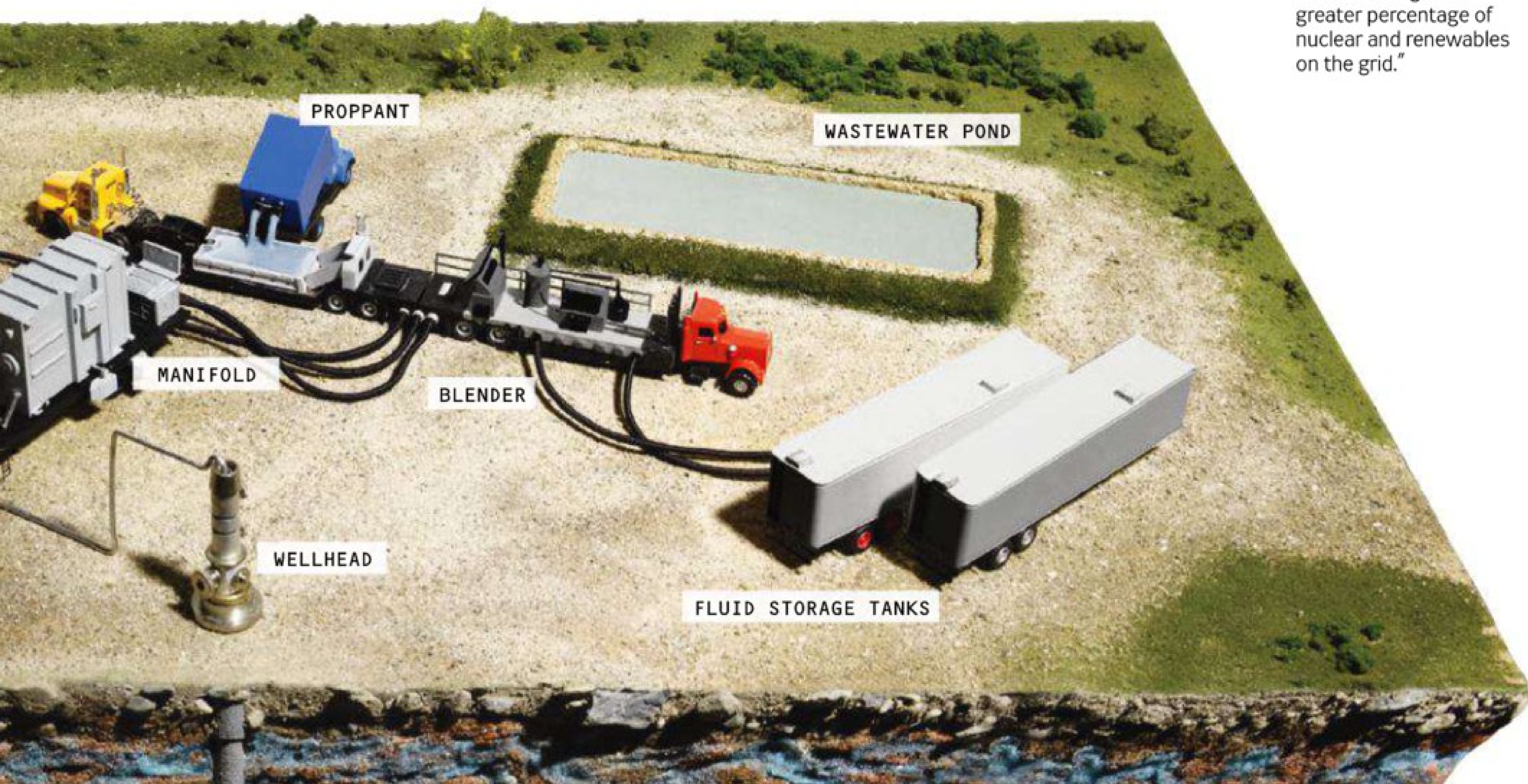
WALL STREET JOURNAL SUMMARIZING AN INTERNATIONAL ENERGY AGENCY REPORT, JUNE 6, 2011

There’s little question that the United States, with 110 years’ worth of natural gas (at the 2009 rate of consumption), is destined to play a major role in the fuel’s development. But even

its most ardent supporters, men like T. Boone Pickens, concede that it should be a bridge fuel between more polluting fossil fuels and cleaner, renewable energy. In the

meantime, the U.S. should continue to invest in solar and wind, conserve power and implement energy-efficient technology. Whether we can effectively manage our natural

gas resource while developing next-gen sources remains to be seen. Margie Tatro, director of fuel and water systems at Sandia National Laboratories, says, “I think natural gas is a transitioning fuel for the electricity sector until we can get a greater percentage of nuclear and renewables on the grid.”



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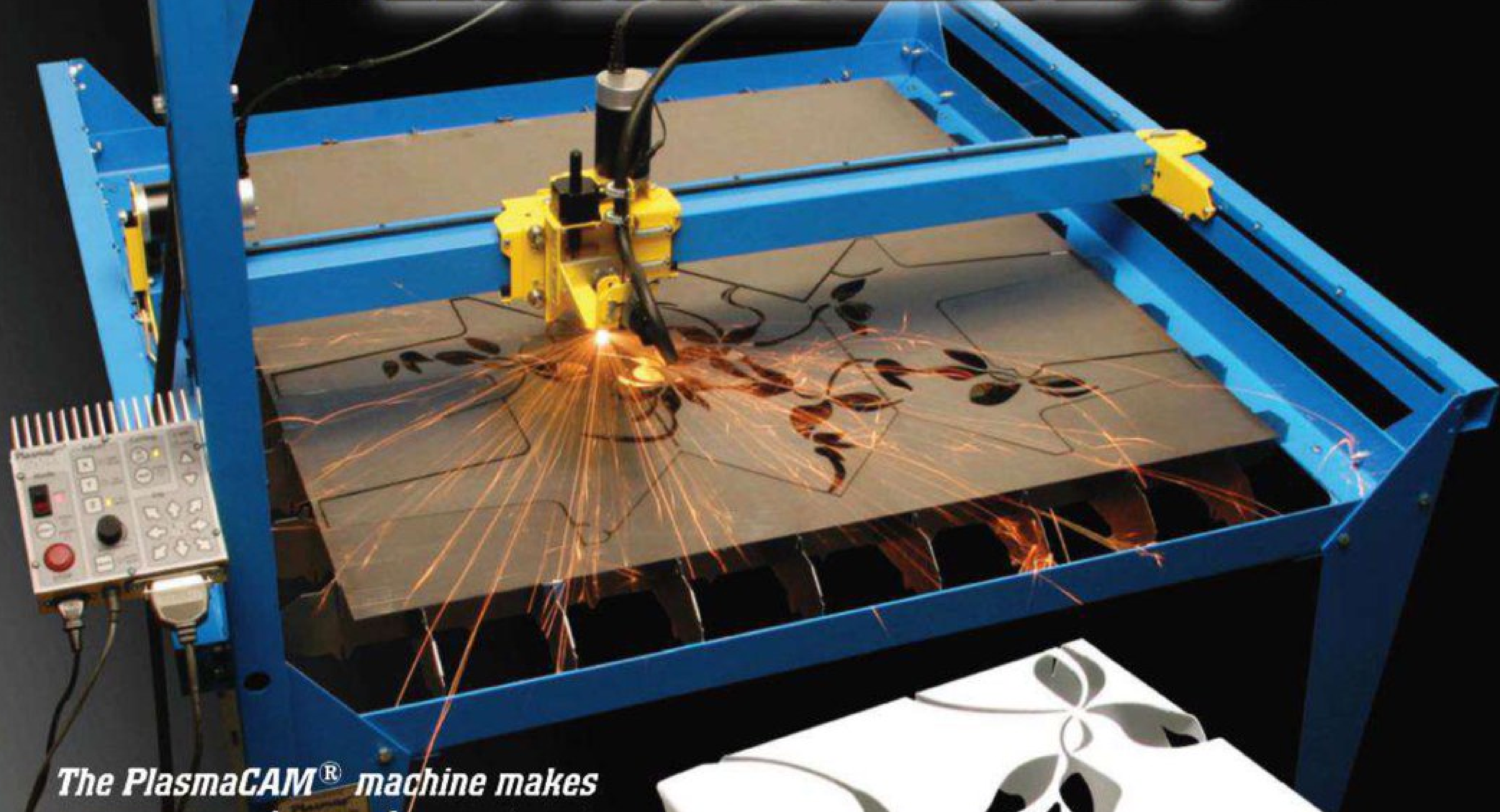
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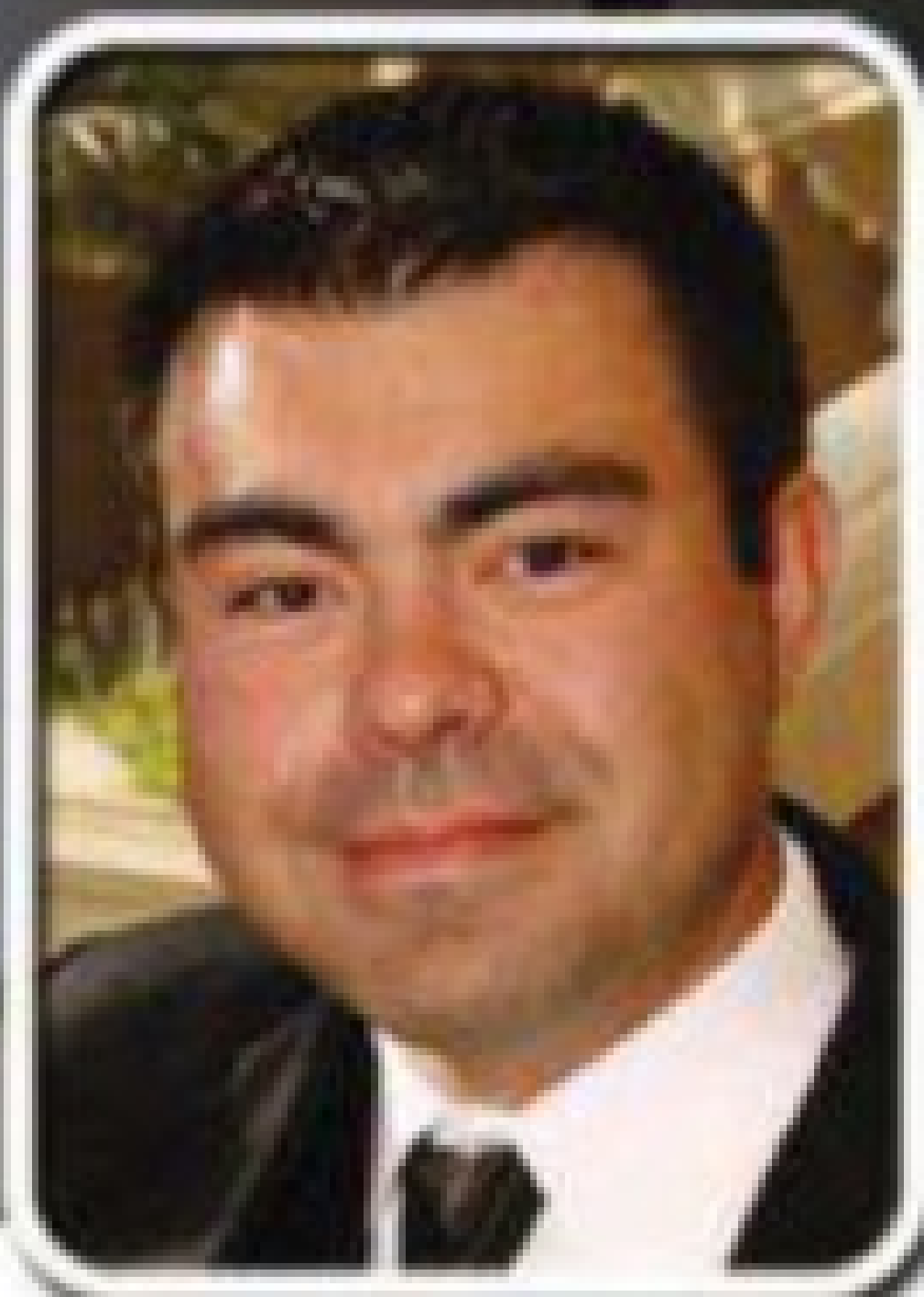
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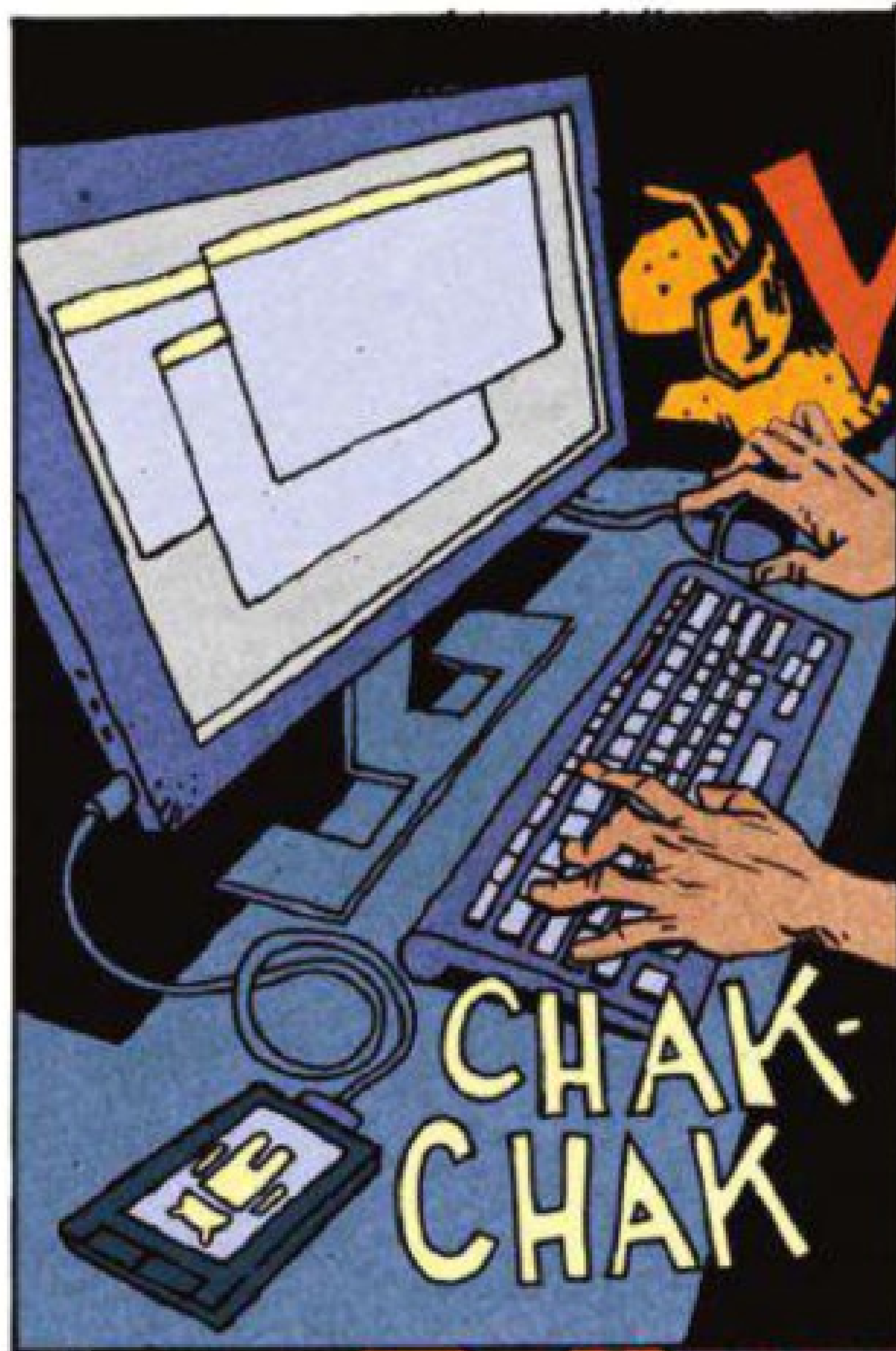
"While shopping, my wife saw an expensive metal table she liked. I offered to make her one, but with my own design & style. Even with little metalworking experience, I imported my sketch and cut out the metal table - all in one piece and with no other materials. The table came out just how I imagined! Plus, several people want to buy my table design. Now I can make my ideas into unique & profitable projects using the PlasmaCAM[®]!"

-Dennis Cordova, Amateur Metalworker



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Make Your Own Apps

CREATING SOFTWARE FOR SMARTPHONES AND TABLETS ISN'T JUST FOR PROFESSIONAL CODERS ANYMORE. BY JOHN HERRMAN

➔ **Before ever suiting up**, all fire-engine operators are taught about friction loss, in which water pressure is reduced by friction inside a fire hose. It's a complicated calculation, dependent on hose diameter, type and length, as well as water velocity. Getting it right is vital. Many departments post cheat sheets for estimating pressure.

INSIDE



TRACKING DATA USAGE + 2D GLASSES + SCREEN HOTSPOTS

ILLUSTRATION BY RONALD WIMBERLY

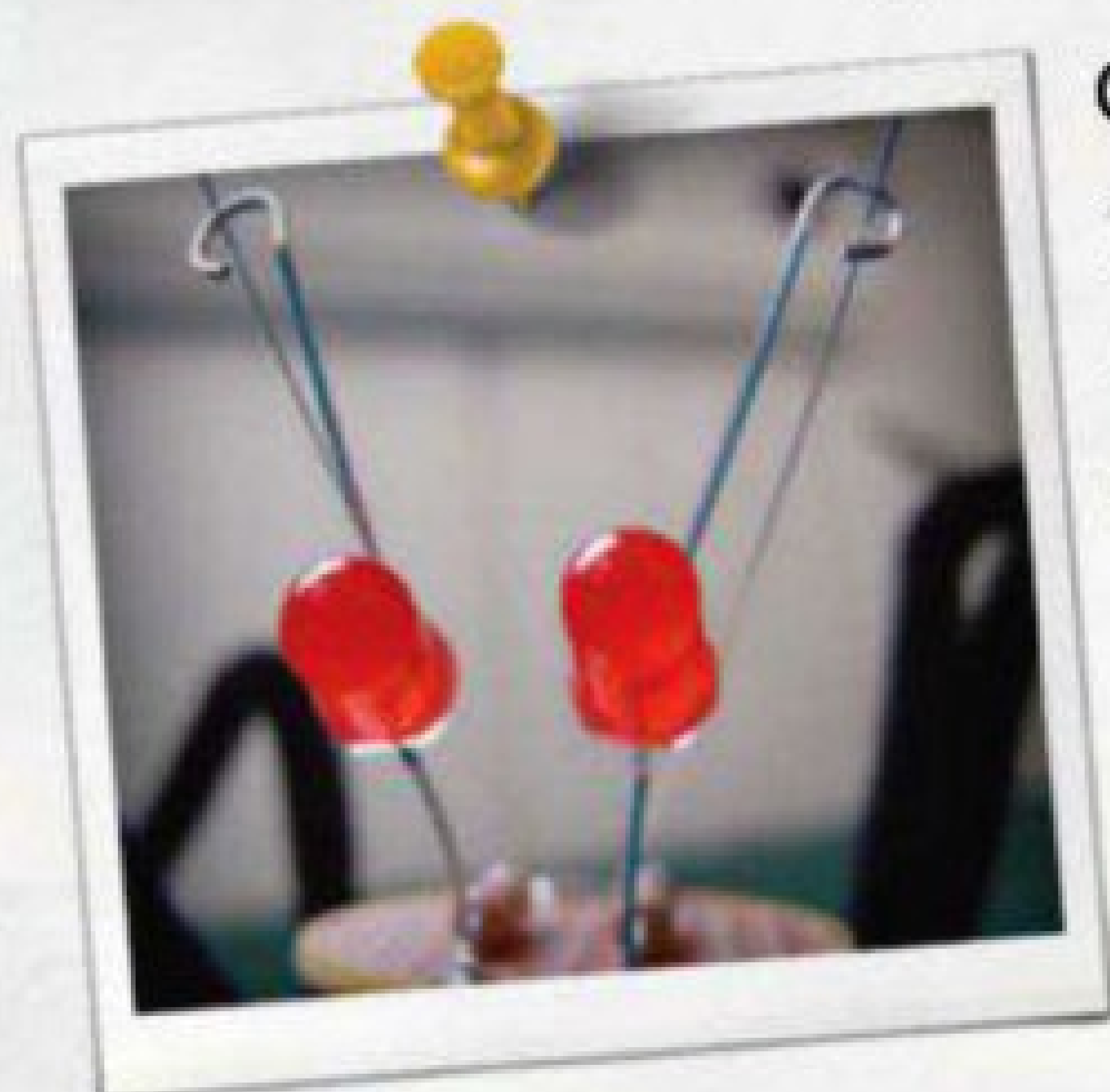
Release: StoreMags & FantaMag



A CELEBRATION OF AMAZING CREATIONS
AND THE PARTS THAT MADE THEM POSSIBLE.

INVASION OF THE BLINKYBUGS

A deceptively simple, motion-sensing “insect”



One afternoon, I was trying to think of a creative use for some electronic components I had lying around when it occurred to me that some of the parts looked very insect-like.

This led to the idea of a simple electric bug that would blink its LED eyes when it sensed vibration. I had some spare guitar strings, which I realized would make the perfect antennae: with the slightest movement, the antennae would make contact with another wire, closing the circuit and causing the eyes to blink!

I called them “blinkybugs” and hid a few around town where I hoped they would surprise passersby. I started running workshops at fairs and museums, where I taught others how to make their own. I was immediately surprised by the cool variations people came up with!

I’ve found that blinkybugs appeal to people of all ages. I think it’s because they’re incredibly simple, yet have vaguely lifelike behavior. Here’s a version that can be made with just a few simple parts.

Solder the LEDs and resistors to the circuit board as shown, connecting the components together on

the opposite side of the board. Make sure to solder the cathode side of the LED to the board. Trim the extra leads, and use a bit of this extra to create an anchor for the guitar string. Bend the string into a V shape with pliers and solder it to the anchor. The guitar string should be positioned so that when the bug is very still, the string rests as closely as possible to the LED’s anode lead without touching it, but when the string vibrates even a little, it rhythmically taps the lead, and your bug springs to life! To make your bug even more blinky, bend the anode leads into little loops and add little flaps of clear tape to the ends of the antennae. Use a bit of hot glue to attach the circuit board to the battery case, and to add some pipe-cleaner legs. Put your bug somewhere it can catch a nice breeze and watch it blink!

About the author: Ken Murphy is a programmer, musician, artist and tinkerer living in San Francisco.



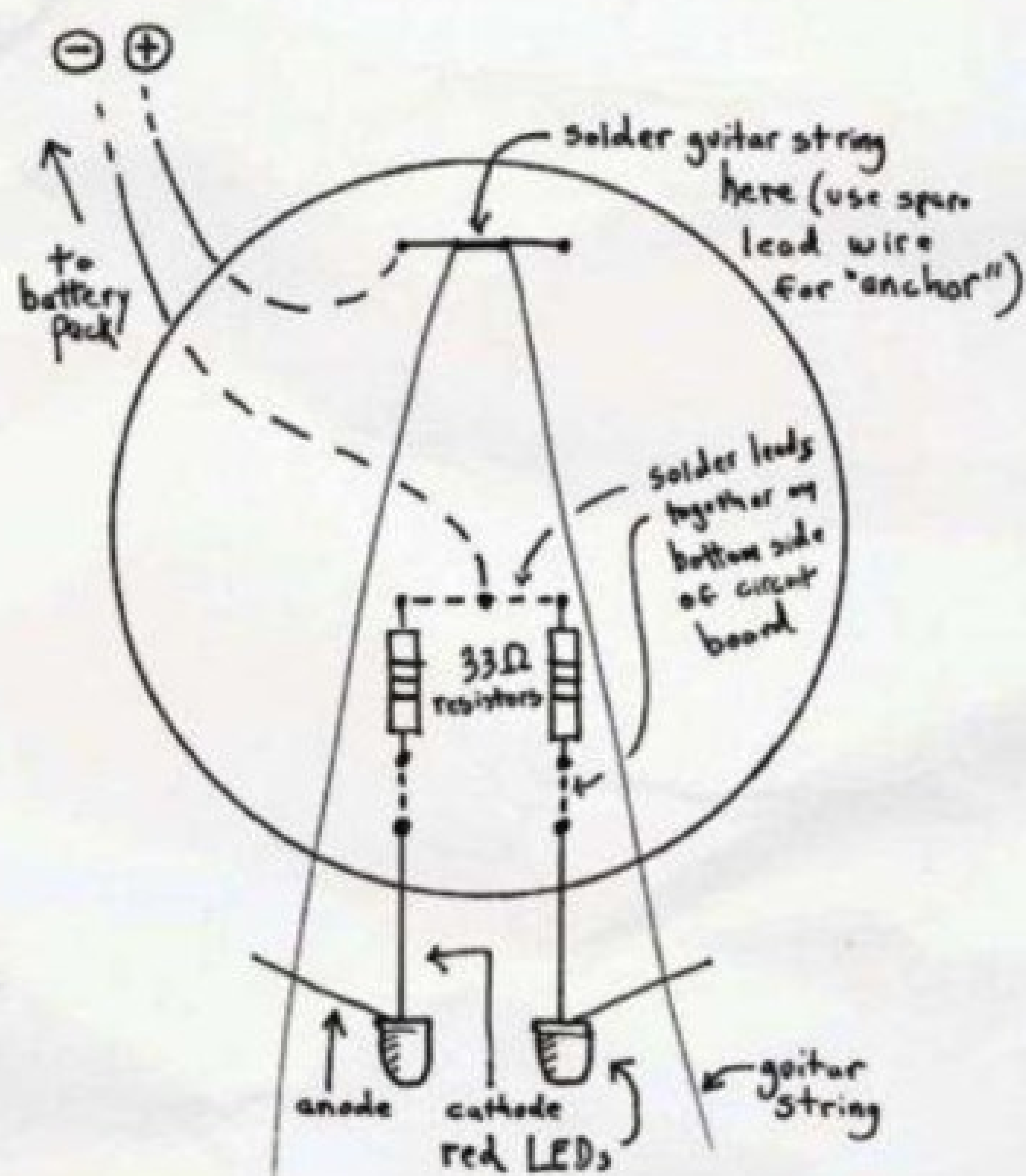
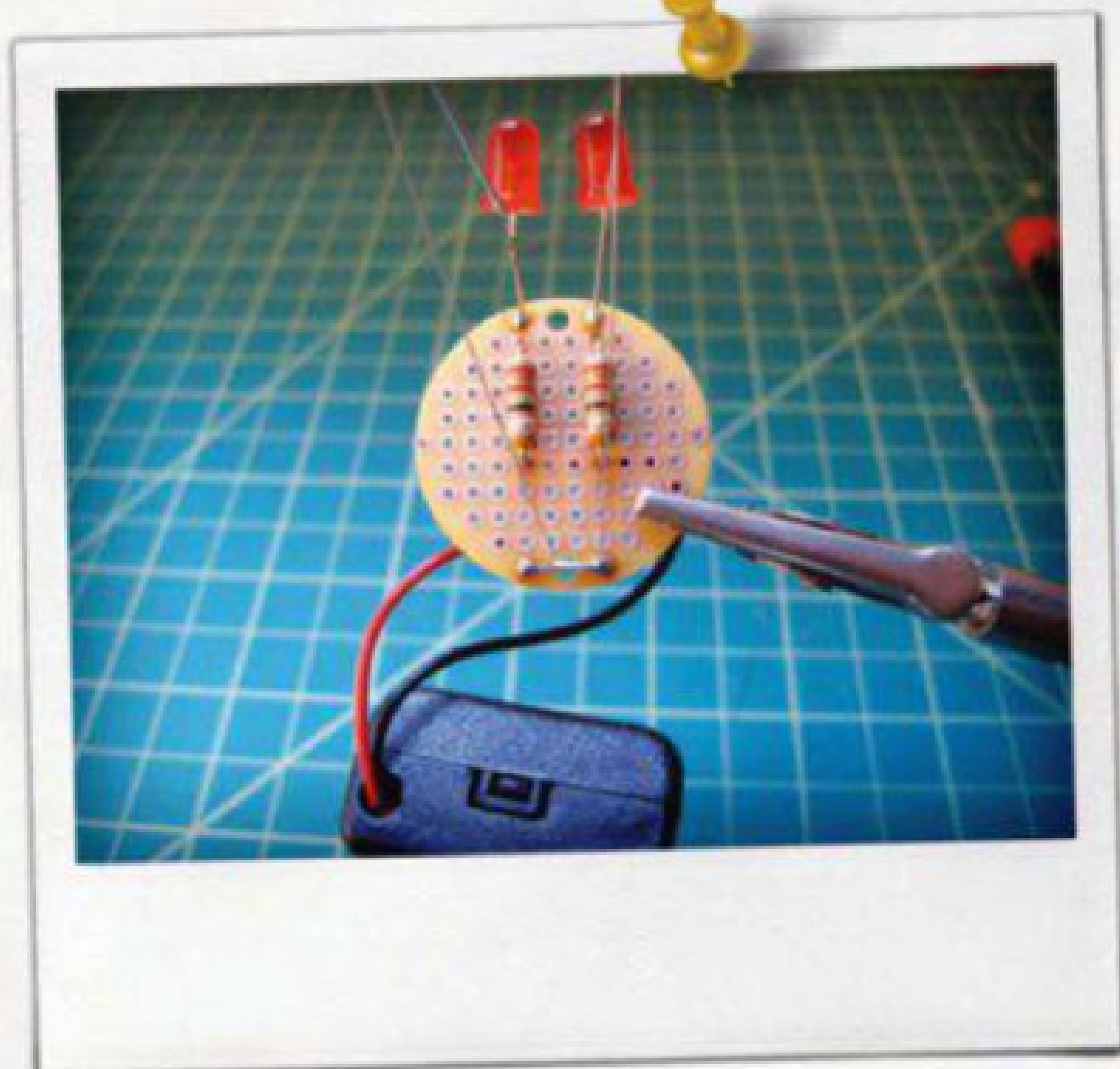
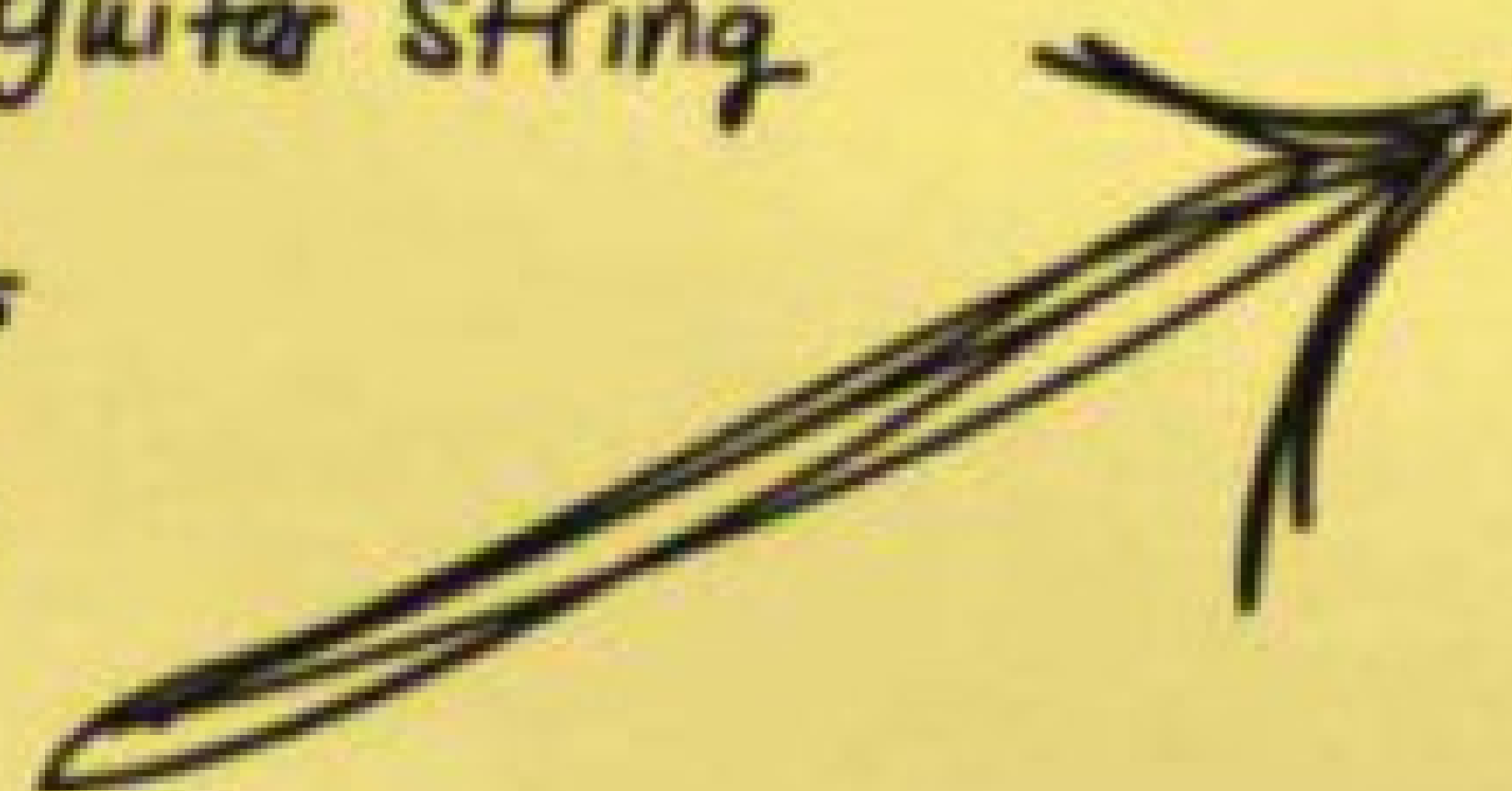
ADVERTORIAL

PARTS YOU NEED:

- "AA" battery case
- 2 "AA" batteries
- A small circuit board
- 2 33-ohm resistors
- 2 red LEDs
- .009 gauge guitar string
- Pipe cleaners
- Solder wire*

TOOLS:

- Soldering iron
- "Helping hands" (helps for positioning guitar string)
- Glue gun



INVASION OF THE BLINKYBUGS FEATURES THESE RadioShack PARTS:

2 33-ohm resistors



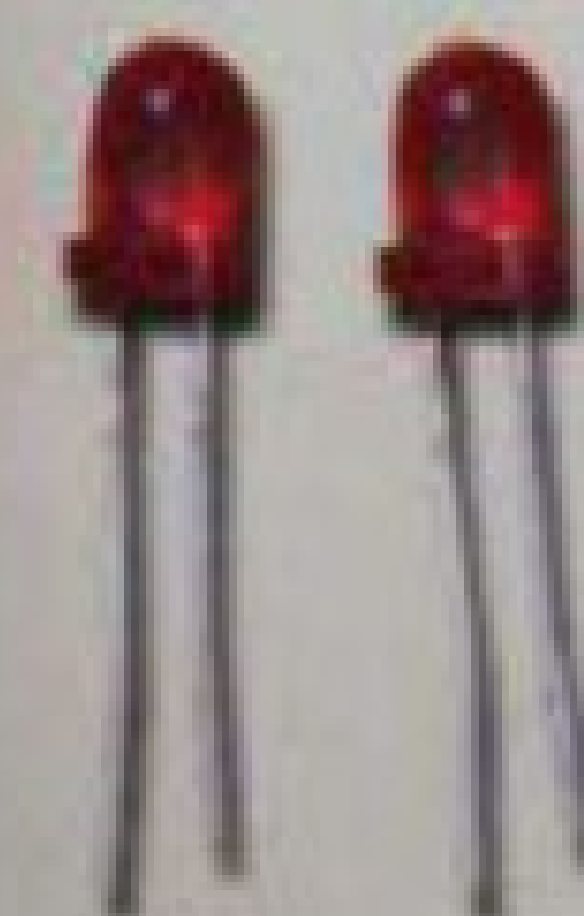
PC boards, round



2 "AA" batteries



Enclosed 2-"AA" battery holder



2 red LEDs

Solder wire*



To submit your own blinkybug creation, explore other great creations and get the hard-to-find parts you need, visit RadioShack.com/DIY

SCAN THIS QR CODE TO LEARN MORE ABOUT THIS PROJECT



Mike Raben, a firefighter in Louisville, Colo., found a more modern solution online: a custom-built calculator app for Google Android phones. He liked what he saw, and had a few ideas for improving it. So, after communicating with the app's creator—a firefighter from northern Virginia named Emmet Carolan—he built his own version, tailored to his particular department's hoses and nozzles, with an added feature for calculating pressure loss due to elevation change.

Here's the twist: Neither Raben nor Carolan are programmers. Their apps were built with Google's App Inventor, one of a wave of new tools designed to allow people without programming experience to create apps and games for their phones and tablets. "That thing caught on like wildfire in the forums,"

says Jason Tyler, author of the recently released instructional book *Google App Inventor for Android*. "This is not just for us nerds."

GameSalad is a similar application for Mac OS, which streamlines the process of creating Web, iPad and, of course, iPhone games to a point where nonprogrammers have found success in the notoriously crowded App Store. Jennifer McGettigan, who uses GameSalad primarily to create children's games (a typical title: *Fairytale Preschool!*), found the tool while employed as a nurse. "When I started using GameSalad," she says, "I had never seen a line of code." McGettigan now has more than 50 games in the App Store, and creating iPhone games has become her full-time job.

How It Works

➔ **Smartphones may inspire** countless "wouldn't it be cool if..." moments, but the gulf between those who can conceive of apps and those who can build them is expansive, and filled with code—cold, syntactical, inscrutable code. This barrier is nearly universal. iPhone developers should be familiar with a programming language called Objective-C. Android developers should be versed in Java. Anyone who wants to code an app for Microsoft Windows Phone had better know C#.

What App Inventor and GameSalad do is automate the creation of code, hiding it from view. Much the way Photoshop is an application for editing images, and iMovie is an application for creating videos, App Inventor and GameSalad are applications for creating... apps.

GameSalad's jarringly stripped-down appearance belies its capabilities. It comes preloaded with sample apps, giving users the ability to tinker immediately. Basic but functional versions of common types of games—top-down racers, variations of the *Angry Birds* concept, and plenty of shooters—provide jumping-off points for a fairly wide range of projects.

Using GameSalad feels more like editing a PowerPoint presentation than developing a mobile application. Two hours after opening the program, I had my own side-scrolling space shooter in the can. It wasn't quite ready for the App Store—my "spaceship" was a crude cutout of my head, and my "laser battles" took place against a photo background of my living room—but nonetheless, it was a game. A few more days of practice could have netted something presentable. It's easy to let your imagination run away with GameSalad, which is probably the point.

Google's App Inventor is a bit more intimidating. A Web-based tool, Google's take on DIY app creation feels more like a simplified version of a traditional developer tool than a piece of consumer software. While it doesn't ask of its users any specific programming knowledge, it does require them

PM APP LAB

GET INTO OUR GAME

➔ Now that anyone can create his own iPad game, POPULAR MECHANICS wanted in on the action. When we mentioned our wish to make the perfect PM game to Mark Chuberka and Billy Garretsen of DIY-game-creation company GameSalad, they offered to do us one better: Not only would they help us create an iPad game that was perfect for PM readers, they would also help get our readers involved.

Our game is called *Be the Spark*, and the idea is to let players explore the fundamentals of internal combustion engine dynamics through the simple task of igniting a spark plug at exactly the right time during the four-cycle process. But what seems simple in a one-cylinder, lawnmower-style engine becomes a maddening finger-frenzy by the time you get to a four-cylinder engine running at 70 to 100 rpm. We're including *Be the Spark* in our September

POPULAR MECHANICS iPad edition. But we'll also be making the game's assets public through GameSalad's free app-building software. That means that anyone who uses GameSalad can tinker with our game. So we encourage you—wait, no, we *challenge* you—to improve upon our game. Add levels, add new engines (we'd love to see a six-, eight- or 12-cylinder, or even a Wankel, engine), or program in a turbocharger or supercharger mode. And if you do invent a better (virtual) engine, we'd like to hear about it. Let us know at pmwebmaster@hearst.com. — GLENN DERENE

to have—or be willing to develop—some understanding of the basics of app architecture, such as how the code interacts with the elements that end up onscreen. What keeps this sometime abstract experience grounded is one novel feature: App Inventor connects directly to your Android phone in real time, allowing you to test your app on your phone as you make changes.

Using App Inventor can feel like an academic exercise. While primarily intended to open up app creation to the greater public, App Inventor is also touted by Google as a teaching tool, bolstered by a tremendous collection of how-to guides, many of them geared toward absolute beginners. My entire time with App Inventor was spent with a tutorial open in a second window, and I also availed myself of guides produced by a large and sympathetic online community. In the end, I got a functional piece of software, but it was several steps shy of a polished app.

What to Expect

➔ **For nonprogrammers** hoping to get into app development for mobile devices, GameSalad and App Inventor extend a welcome lifeline. The apps they produce, though, are inherently limited. In other words, established programmers and game designers have nothing

to fear. Not yet.

GameSalad and, to a lesser extent, App Inventor trade certain capabilities for ease of use. For many types of projects, this isn't an issue. A well-designed 2D shoot'em-up game made in GameSalad can be just as fun and rich as a similar app developed with more advanced tools.

But many of the most popular titles in the App Store and Android Market, such as 3D games and full-feature social-networking apps, are impossible to build with a modular, drag-and-drop creation tool. Even new developers might chafe against the constraints; GameSalad, for example, uses a single physics model for object movement and interaction. The physics engine may feel natural in a *Pong*-style game, but if you need to design, say, a complex suspension system for a car game, you'll find your options are limited.

For Google, beginner-friendly app creation is still an experiment. App Inventor is offered for free, as is membership in Google's Android Developer program, but the company doesn't yet officially endorse the uploading of App Inventor apps to the Android Market. There are various tutorials and services available to help prepare apps for publication, but this omission seems like a tacit acknowledgment that App Inventor isn't quite ready for the big time.

GameSalad, on the other hand, is explicitly geared toward releasing titles in Apple's mobile and desktop app stores. The free version of the app produces games ready to be submitted to the App Store. The paid version, which costs \$499 a year, lets you insert Apple iAds into applications, an important and increasingly common source of revenue. Then, of course, there's Apple's iOS developer fee—\$99 per year—to distribute any apps through the App Store.

While it's possible to make real money using these tools—McGettigan says she is happy with the income from her apps, and that GameSalad enabled her to achieve a lifelong dream of working in the gaming industry—such stories are the exception rather than the rule. But that's unfortunately true for trained programmers, too.

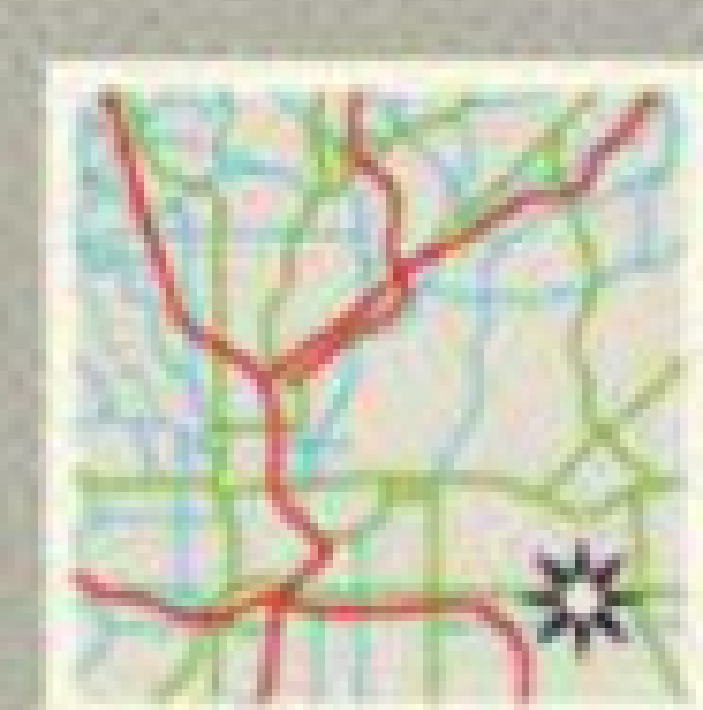
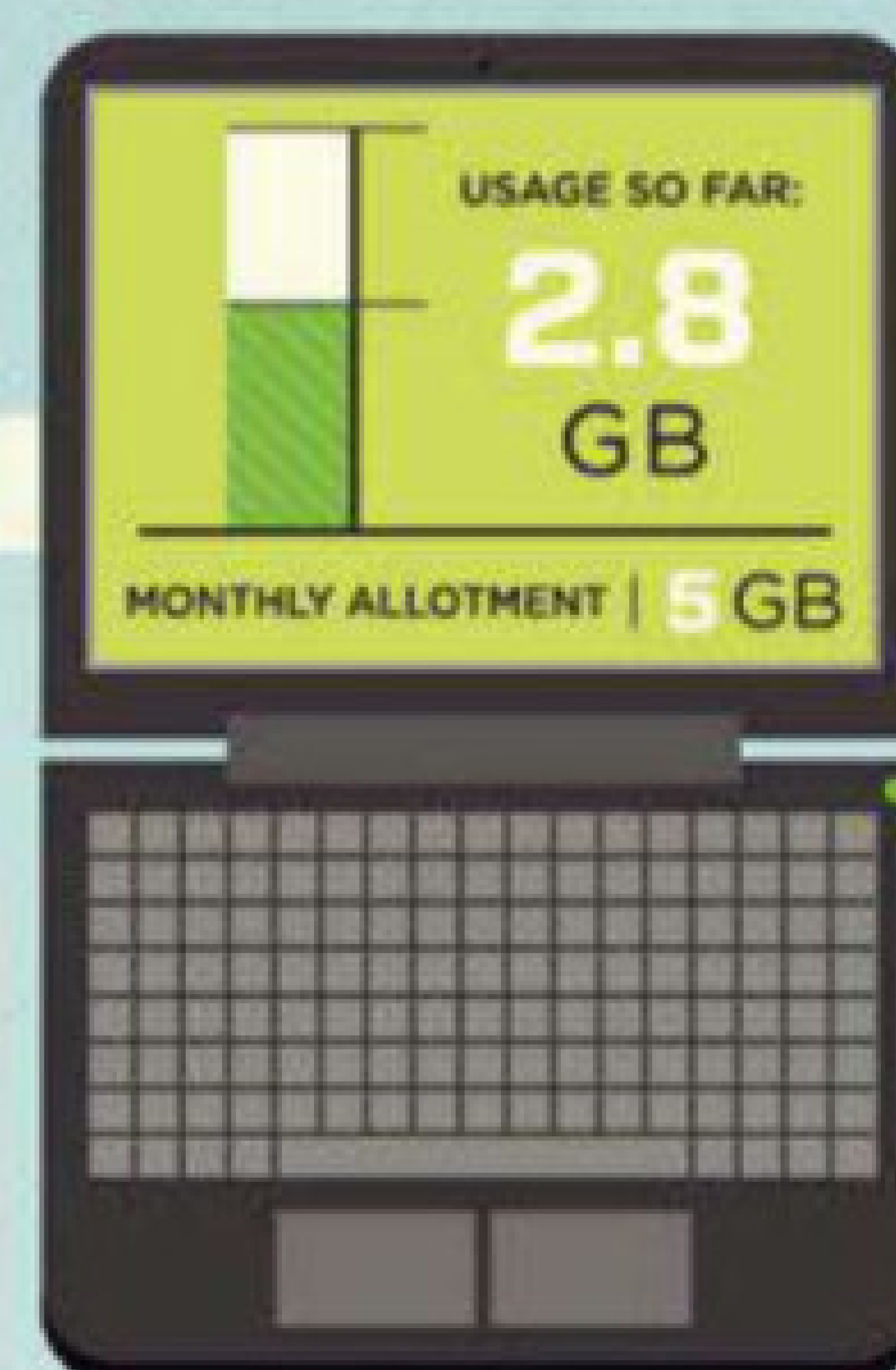
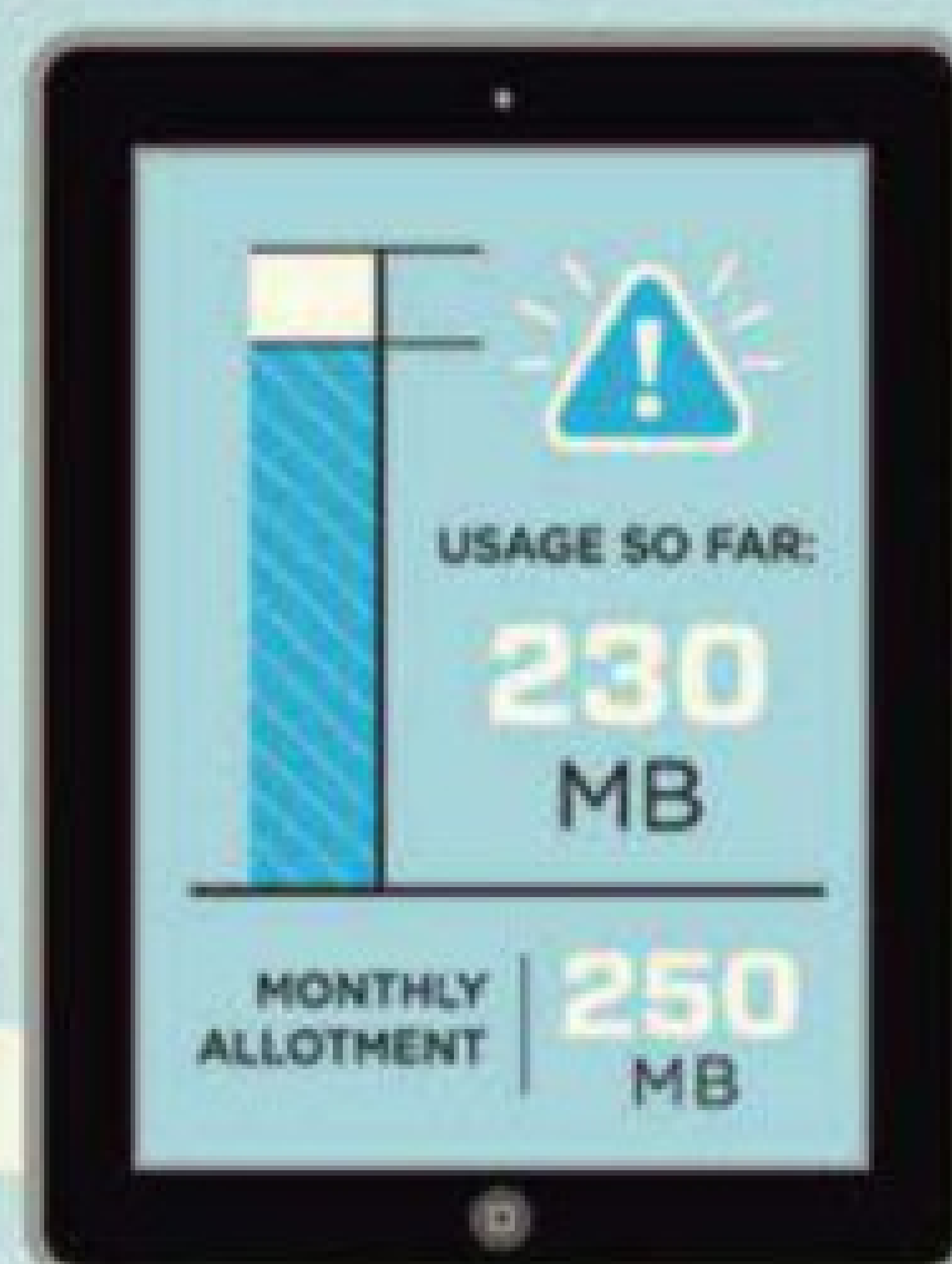
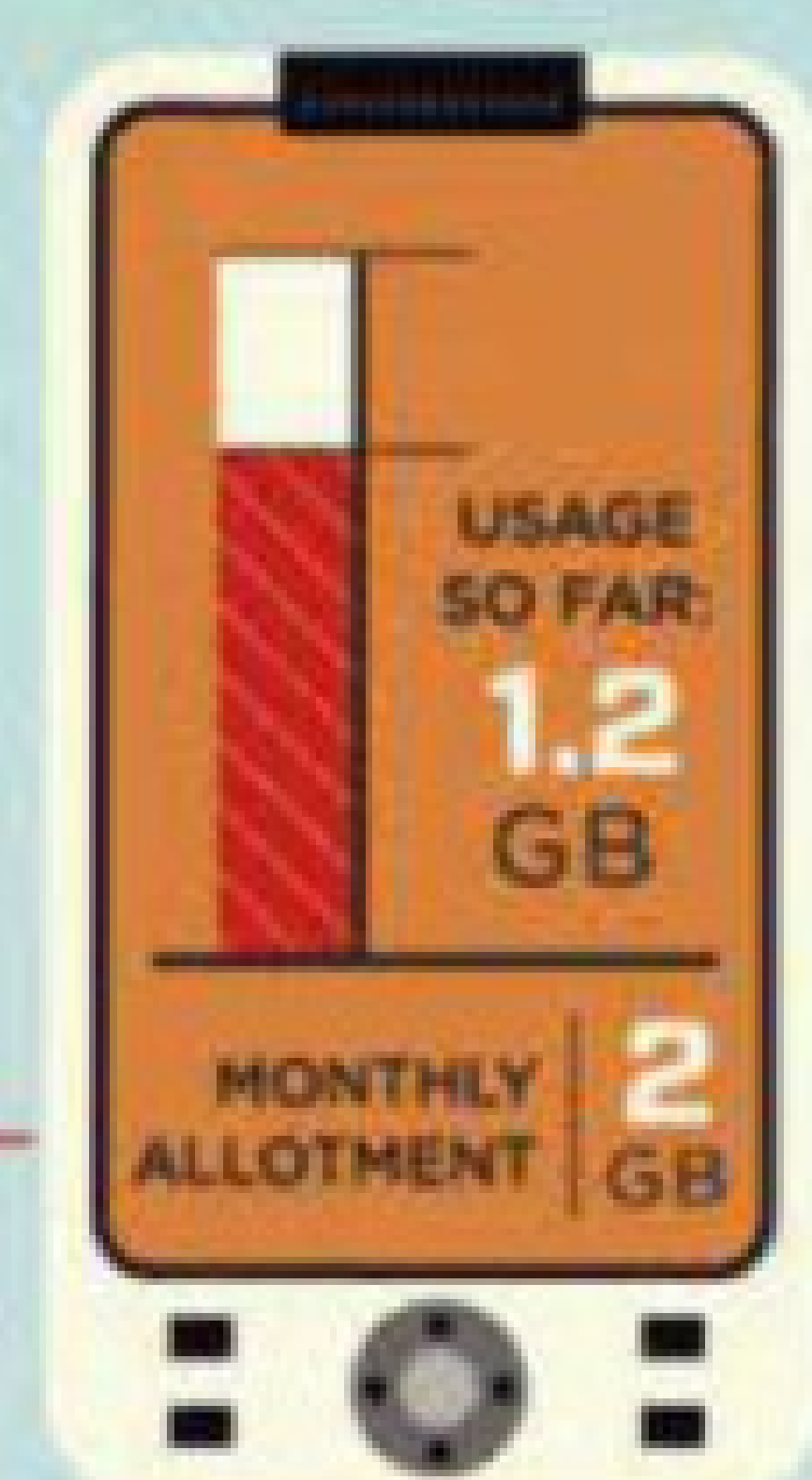
In the end, the biggest drawback to DIY-app-creation software is the high expectations it inspires. App Inventor and GameSalad may topple formidable entry barriers for newbies, but writing code is just one of a heap of challenges facing a new developer. These tools won't guarantee an app is attractive, intuitively designed, enjoyable to use or marketable. They can help make sure good app concepts don't get needlessly shelved; coming up with that winning idea, however, is still up to you. **PM**



Digital Clinic

by John Herrman

Q+A



Tracking Data Plans

On my last cellphone bill, I noticed I was paying for 2 GB of data access. I occasionally tether my phone but doubt I use nearly that much. How can I keep track?

A Cellphone carriers are nothing if not cunning. Looking at available data plans from companies such as AT&T and Verizon, you can see a pattern. The more expensive option buys more data than you could ever use, while the less expensive options are bare-bones enough to scare you into paying more, even if you don't know how much data you actually use. The solution is simple: Find out.

AT&T and Verizon both offer free tools to their customers for tracking data usage on an iPhone. (Search in the Apple App Store for My Verizon Mobile or myAT&T.) A third free app called Consume can track AT&T raw download and upload amounts as well as dozens of other services, including home broadband. Android users on any carrier can enter their wireless plan account information into a free app called

3G Watchdog, which can be set to send usage as total transfers approach monthly limits. You may be surprised at how much you use: By Nielsen's count, Android users averaged 582 MB a month; iPhoners racked up 492.

While we've grown used to effectively unlimited home broadband connections, the proliferation of 3G and 4G wireless access in laptops means we need to get back into the habit of minding our bits when we're not connected to Wi-Fi. Wireless providers typically include a free, basic data-tracking app with their wireless adapters. For Windows users who want more detailed tracking—or don't really trust their wireless providers—a free app called NetWorx conveniently displays data usage in numerical or graph form, and can even archive detailed reports in Word and Excel formats. (Alternatively,

BitMeter OS sends your usage information to a local website, which, when you are on your home network, you can visit from any computer in your house.) Mac users can try a similar app called SurplusMeter, which tracks data usage against monthly allowances.

Screen Hotspots 📶 I have a 3-year-old laptop that has lately developed a small, nickel-size bright spot on the screen that won't go away. What's causing it, and is there anything I can do?

This unfortunate phenomenon is known as mura—a word that comes from a Japanese term for unevenness. A quality TV or monitor factory is not likely to ship a screen with a mura defect, but according to Bruce Berkoff of the LCD TV Association, mura effects often appear later in a screen's life as the result of an impact to the screen—an all too common occurrence in laptops. "LCDs are like a glass sandwich that is soft in the middle," he says. And a smack to the screen could be enough to compromise one of the screen layers without actually cracking the glass. That would disrupt the light path and make the screen appear brighter or darker in one section.

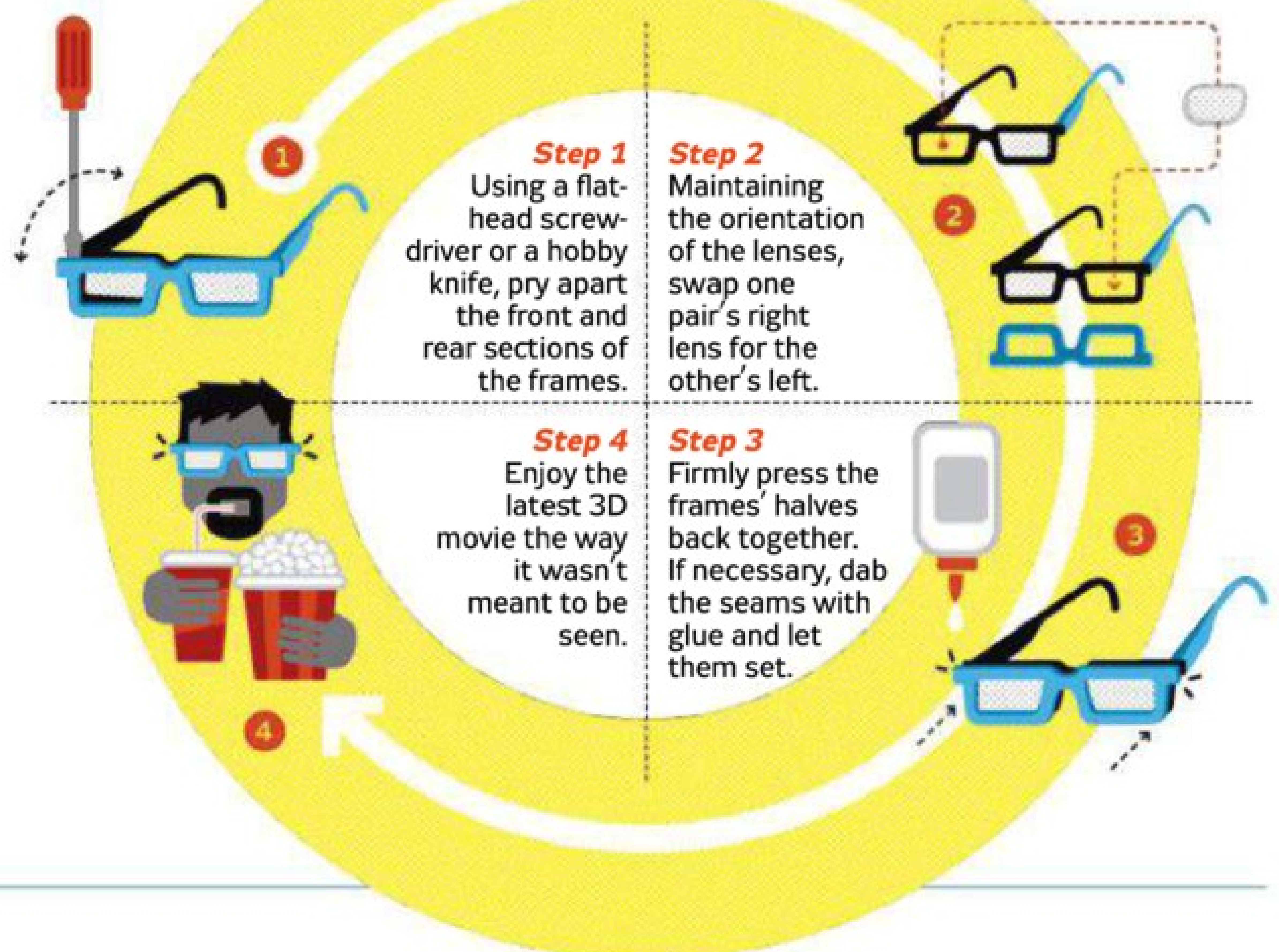
Unfortunately, this is one of those situations where the fix could be more



DISPATCHES FROM FLATLAND

DE-3D GLASSES

➔ Maybe you're one of the millions of people who experience physical discomfort while watching 3D movies, or perhaps you've just got 3D fatigue. Either way, there's finally something you can do about it. Within every 3D movie is a pair of 2D movies, each recorded from a slightly different perspective. Most 3D glasses use polarized lenses to direct a different stream to each eye, giving the impression of 3D. For \$10, the clever folks at 2d-glasses.com will send you theater-ready specs that eliminate one of these channels entirely, directing one channel to both eyes and turning a 3D movie into 2D. Or, with two pairs of 3D glasses from your local multiplex and a little handiwork, you can make a zero-cost headache-free pair of your own.



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DIY

Tech DIGITAL CLINIC Q+A

expensive than a replacement, especially with an older machine. Repairing a laptop screen can cost hundreds of dollars, which could probably cover most of the price of a new computer.

Google, Gone ➔ I heard that Google sites such as Gmail and Google Docs aren't going to support older browsers after a certain date. Do I need to upgrade? What if I can't?

If you were to ask Google what was happening on Aug. 1, they'd tell you they were "encouraging users to update their browsers." This is a worthy cause: Today's browsers are faster, more secure and capable of running much more impressive Web apps than their predecessors. But Google isn't requiring anyone to upgrade, nor is it shutting anything down. The company is just not going to take extra pains to make sure that new features in Gmail, Google Docs and other Web apps, including drag-and-drop images or desktop notifications, work in older browsers. By not requiring its engineers to cater to out-of-date software, Google can take advantage of newer browser capabilities such as HTML5 to make its sites more like apps and less like Web pages.

But what about the stragglers? Many companies don't—or can't—upgrade their computer systems very often, leaving employees using outdated versions of Internet Explorer. Likewise, personal computers with older versions of Windows or Mac OS may not be compatible with newer browsers at all. Rajen Sheth, group product manager for Google Enterprise, tells PM that the changes won't be drastic in the near future. "Nothing will break per se," Sheth says, "but certain newer features might not work on older browsers."

In any case, upgrading is a good idea, if possible. Google is far from the only company that wants to leverage new browser technologies—the newest version of Microsoft's SkyDrive site uses HTML5 for photo galleries, and Apple's home page uses it for navigation—but sticking with an old browser version is your loss, not theirs. Go to whatbrowser.org to check your browser version and see the alternatives—they're all free.

Monitor or HDTV? ➔ I'm looking for a large, 1080p computer screen. Twenty-six-inch monitors are pricey, but I've found some HDTVs that seem to

meet my requirements at a much lower price. Is there any reason not to go with the HDTV?

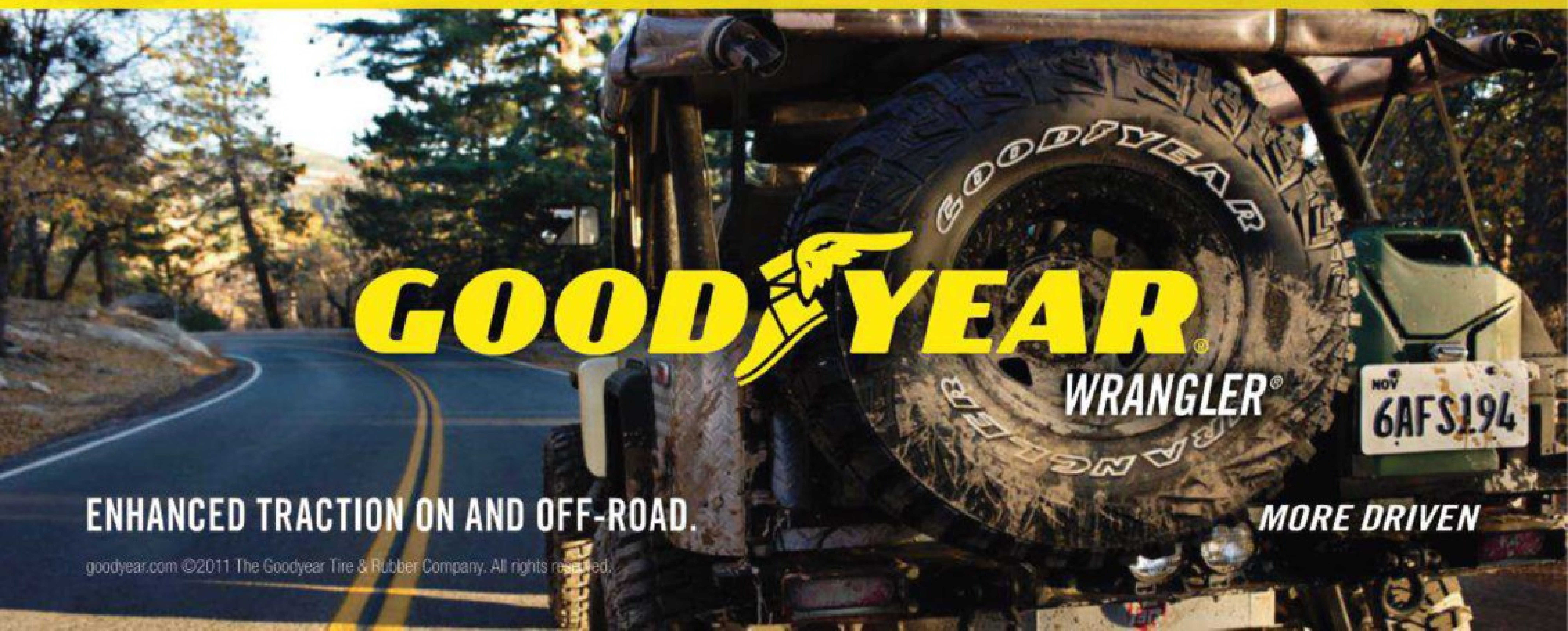
By definition, an HDTV differs from a computer monitor in three ways: It has a TV tuner, it comes with a remote, and it features built-in speakers. On the other hand, a monitor may include a wider range of computer-specific video connectors, such as DVI and VGA.

In cases where an HDTV is much cheaper than a seemingly equivalent monitor, the differences may run deeper. Raymond Soneira, president of display-testing firm DisplayMate, warns that sub-30-inch HDTVs are often built using cheaper, twisted nematic (TN) LCDs, rather than the high-performance panels found in monitors and large TVs. While you might save cash by going with a TN-based HDTV, you'll pay for it in poor color reproduction and a limited viewing angle. Get a monitor—your eyes will thank you.

PM

Got a technology problem?

Ask John about it. Send your questions to pmdigitalclinic@hearst.com or post on Twitter at [@jwherrman](https://twitter.com/jwherrman). While we cannot answer questions individually, problems of general interest will be discussed in the column.



GOODYEAR

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Home

Sparks Will Fly

WE TEST SIX WIRE-FEED WELDERS AND FIND GOOD THINGS DO COME IN SMALL PACKAGES.
BY ROY BERENDSOHN

Welding is so hot, it's cool. It doesn't get better than fusing two pieces of steel with a thin ribbon of molten metal. PM has covered electric-arc welding since the 1920s, and lately we've noticed a major revival of interest in it. Helping to drive that is the wire-feed welder, a compact machine that feeds a thin wire electrode down a hollow cable to a small plastic gun. It's easy to use: Strike an arc with the wire and move the gun down the joint. Enlisting the help of senior auto editor Mike Allen, PM's resident welder, we gathered six machines and went to work on low-carbon steel. We learned that all the welders are more than enough for the home workshop. After the smoke cleared, we flipped up our masks and rendered our findings.

INSIDE

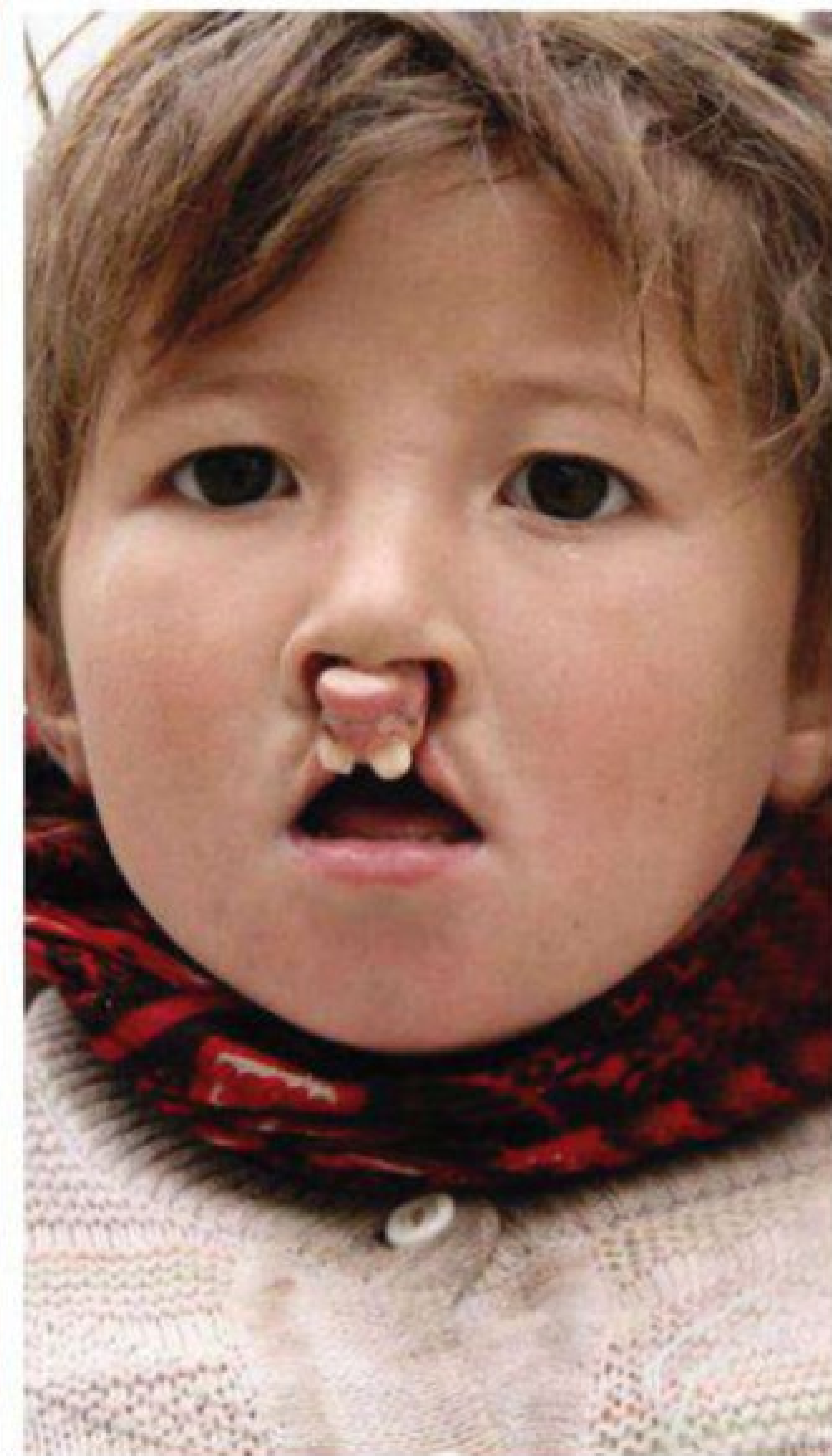
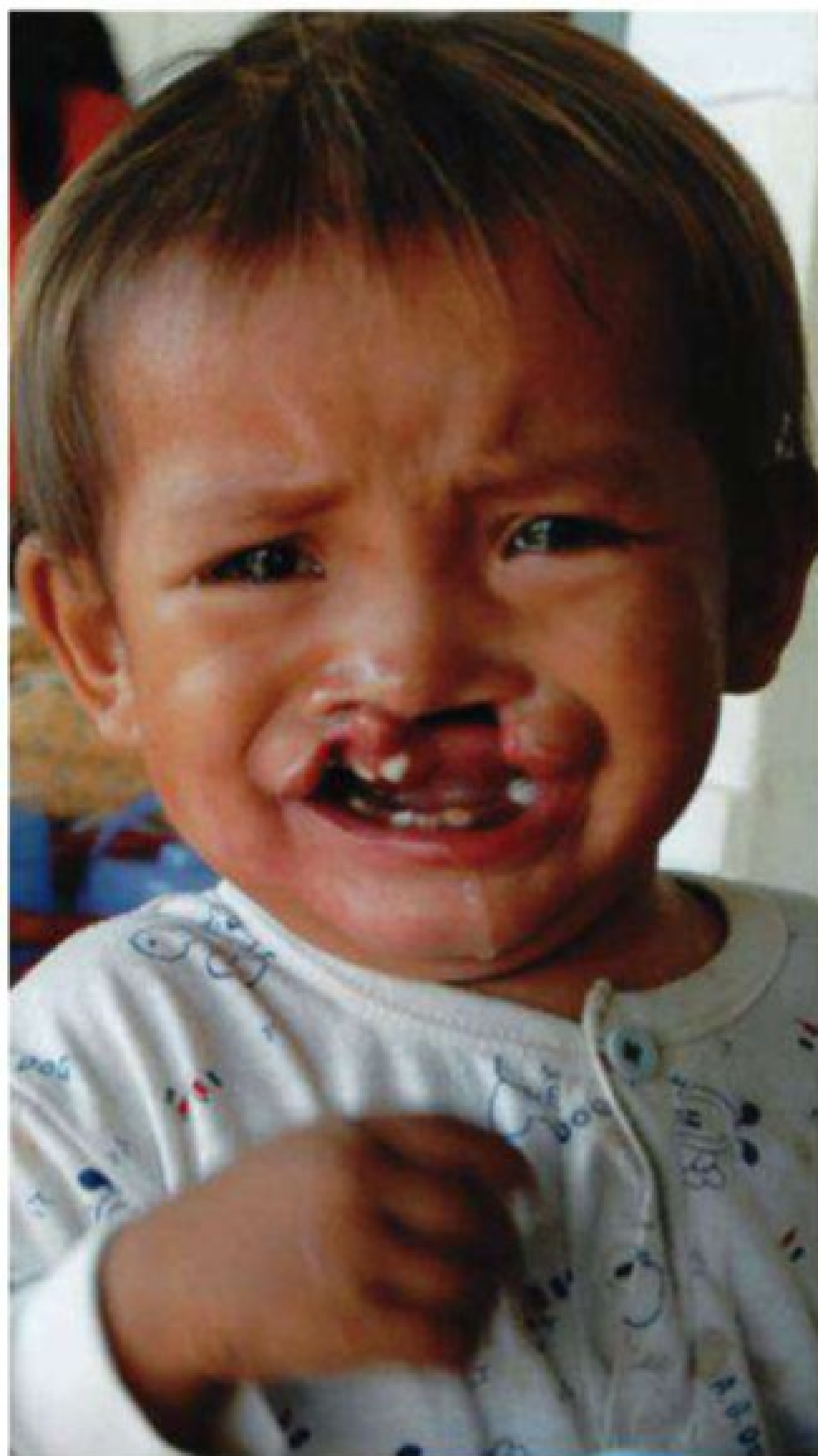


COVERING CHAIRS & GRILLS + BUILD A HAMMOCK FRAME + THE TRADITIONAL TIN-ROOF SHED

PHOTOGRAPH BY THOMAS PRIOR

STYLING BY JESSICA GRIFFIN

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Release: StoreMags & FantaMag

DIY

Home WELDER TEST

Rating

CAMPBELL
HAUSFELD
PRO-140
WG3090Price:
\$370EASTWOOD
MIG 135Price:
\$340HOBART
HANDLER 140Price:
\$666

WELDING RANGE: 24 gauge to 1/4 in. **DUTY CYCLE:** 20 percent
WEIGHT: 64 lb **CURRENT DRAW, 1/8-IN. STEEL:** 28–30 amps

LIKES: This homeowner-grade machine offers a lot to like. It has an all-metal drivewheel assembly, and many of its adjustments can be made without tools. Its work clamp has a nice big braided copper strap across its jaws to ensure conductivity through the weld circuit. Most important, it's easy to handle; associate editor and first-time welder Harry Sawyers flawlessly seamed two pieces of bar stock after just a couple of test runs.

DISLIKES: The cooling fan hit its cover, creating a racket. We fixed it, but then it started in again.

WELDING RANGE: 24 gauge to 1/4 in. **DUTY CYCLE:** 20 percent
WEIGHT: 45 lb **CURRENT DRAW, 1/8-IN. STEEL:** 24–27 amps

LIKES: Eastwood's machine is a good general welder, and we were pleased that it handles both horizontal and vertical welding so nicely. Its strong suit for the old-car crowd is that it does a beautiful job welding sheet metal. After a little practice, Mike had the infinitely adjustable voltage dialed in, and pulled flawlessly tiny beads down the center of our sheet-metal samples. We also liked that the gun cable and its work-clamp lead were 8 feet long.

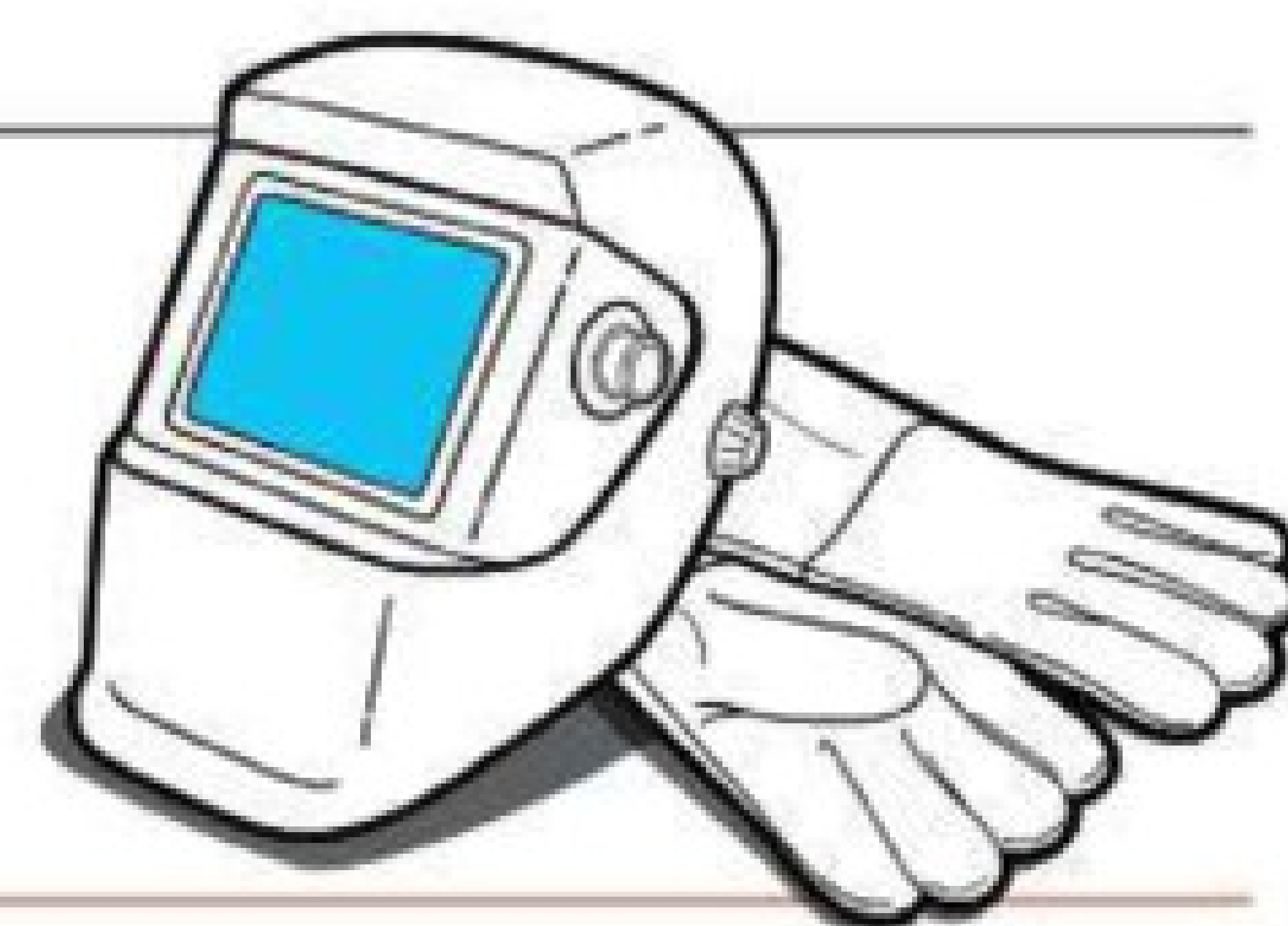
DISLIKES: Changing the wire spool is a fussy procedure that "requires three hands," as one of our testers said.

WELDING RANGE: 24 gauge to 1/4 in. **DUTY CYCLE:** 20 percent
WEIGHT: 64 lb **CURRENT DRAW, 1/8-IN. STEEL:** 28–30 amps

LIKES: When you spend an extra \$300 for an American-made welder, what do you get? Guts. The Handler has 'em. Its beefy aluminum bus bar (to connect for flux-cored- or solid-steel-wire welding) looks like something out of a power plant. Do guts equal weld quality? Yes. The Hobart has excellent arc stability on both sheet metal and bar stock, on horizontal and vertical surfaces.

DISLIKES: We didn't experience problems with it, but the wire drive, complete with plastic parts, didn't look as rugged as the rest of the welder.

WELDING SAFETY → All the welders were nominally rated as approximately 20-amp machines. Measuring the current at the service panel, we found that they would spike as high as 45 amps and weld at an amperage above their rating. We recommend upgrading the wiring, circuit breaker and receptacle serving your welder. While you're at it, buy a welding jacket or a leather welding apron, an auto-darkening welding mask, safety glasses and leather gloves. Position a fire extinguisher close by, and clear the welding zone of anything that could catch fire.



PHOTOGRAPHS BY CHAD HUNT

ILLUSTRATION BY MERCE IGLESIAS

Rating

WELDING RANGE: 24 gauge to $\frac{3}{16}$ in. **DUTY CYCLE:** 20 percent
WEIGHT: 58 lb **CURRENT DRAW, $\frac{1}{8}$ -IN. STEEL:** 32–35 amps

LIKES: Lincoln equips this welder with a diamond-shaped choke (an electronic filter that it calls Diamond Core technology). The company claims that it stabilizes the welding arc, provides easier starts and makes for better welding at high or low wire speeds. It also says this creates better control of the weld puddle—the tiny pool of molten metal next to the arc. We found Lincoln's description accurate. Glide its gun down or up the joint and leave a perfectly consistent bead.

DISLIKES: A tad better industrial design is called for on how the work lead and the power cable connect to the polarity posts. You have to put an unnecessarily sharp bend in the cables when you place them for MIG (metal-inert-gas) or flux-cored settings.

WELDING RANGE: 24 gauge to $\frac{3}{8}$ in. **DUTY CYCLE:** 30 percent
WEIGHT: 70 lb **CURRENT DRAW, $\frac{1}{8}$ -IN. STEEL:** 30–33 amps

LIKES: The Miller is so powerful and capable that we decided it was a little unfair to match it against the others. This is a superb industrial tool, and it's priced accordingly. The extra cost is justified by features such as dual welding voltage (120 and 240 volts) and hefty components—the area of the brass contact on the end of its gun cable is about three times that of a typical wire-feed welder. Welding power a problem? We bet you could go thicker than the Miller's $\frac{3}{8}$ -inch-steel rating. It's so hot, we dialed back on its recommended settings and still had power to spare. And arc stability? With this machine, you're in for a smooth ride—flying first-class on Miller Airways, baby.

DISLIKES: None.

WELDING RANGE: 22 gauge to $\frac{3}{16}$ in. **DUTY CYCLE:** 20 percent
WEIGHT: 47 lb **CURRENT DRAW, $\frac{1}{8}$ -IN. STEEL:** 27–30 amps

LIKES: Every beginner wonders how much machine to buy. You need not be concerned about this entry-level welder. If you're building light-duty projects and repairing things around the house, this is more than enough machine. That's what it's rated for, and within minutes of removing it from the box, we were pulling nice clean beads without having to bother with the controls or wire drive. It's basic, but it's good.

DISLIKES: The wire-drive feed is made of plastic; we prefer that part to be metal.



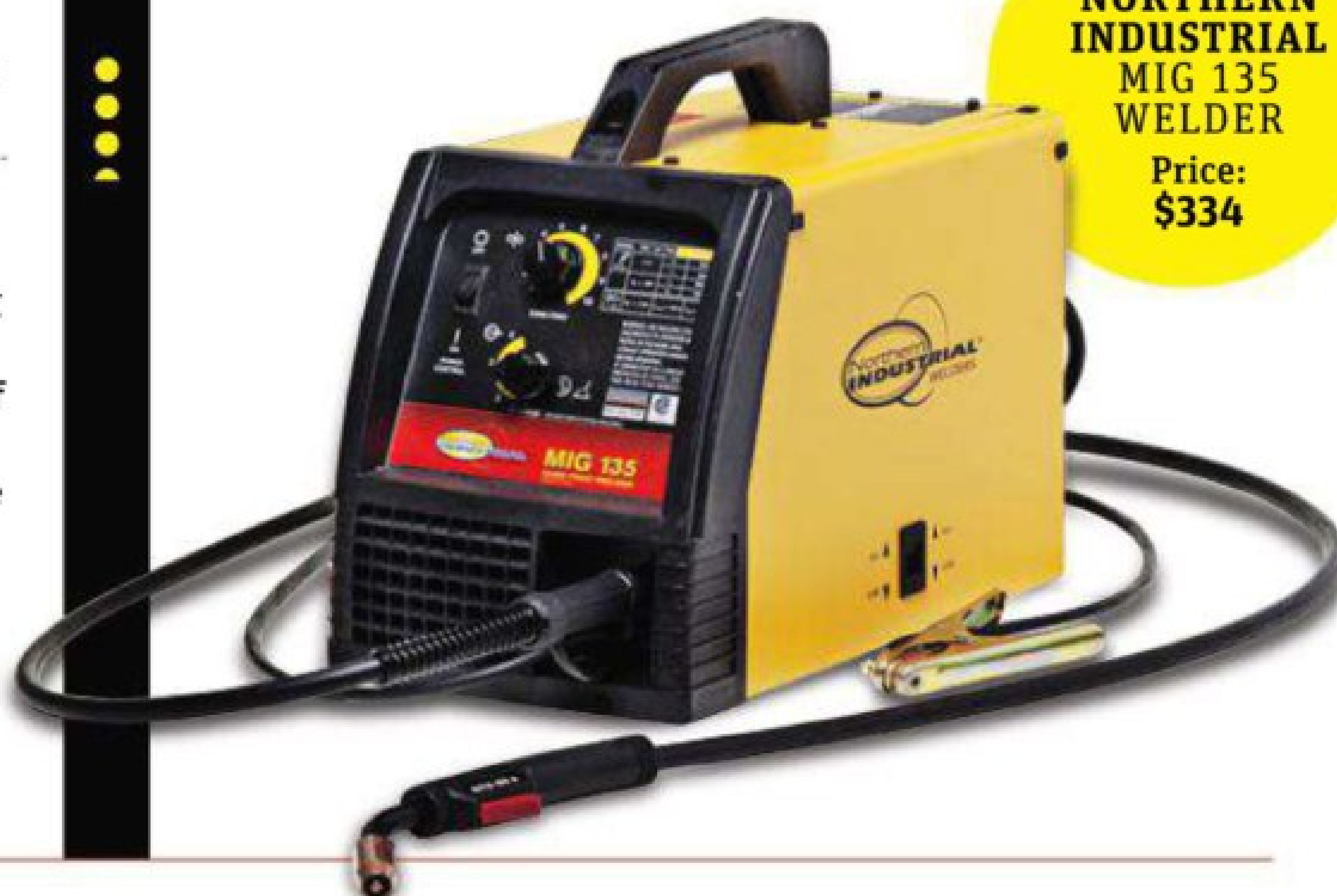
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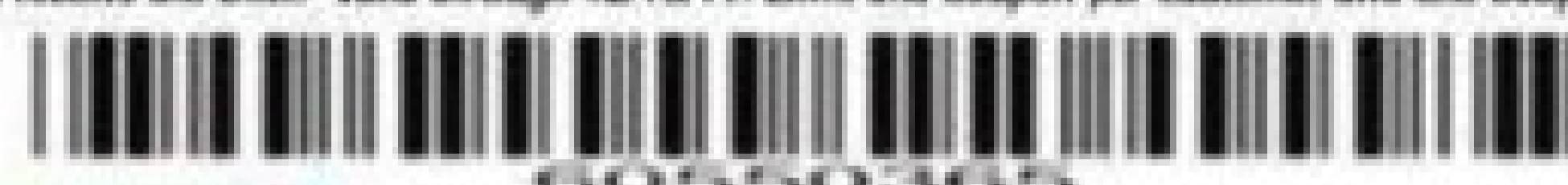
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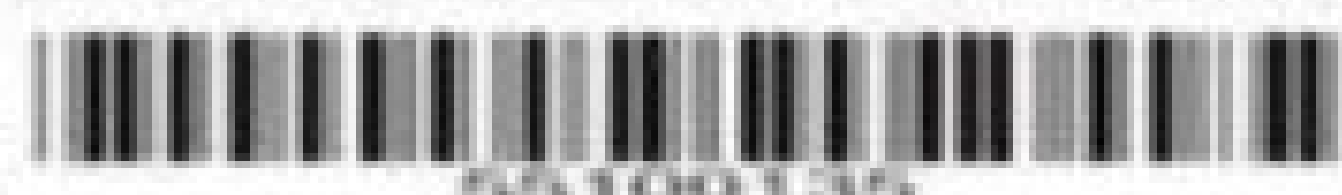
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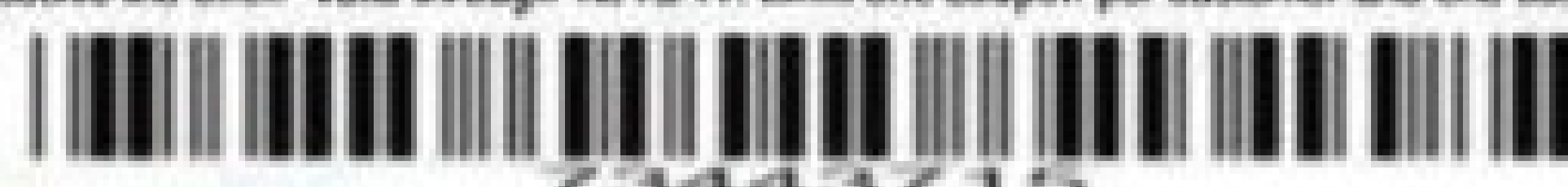
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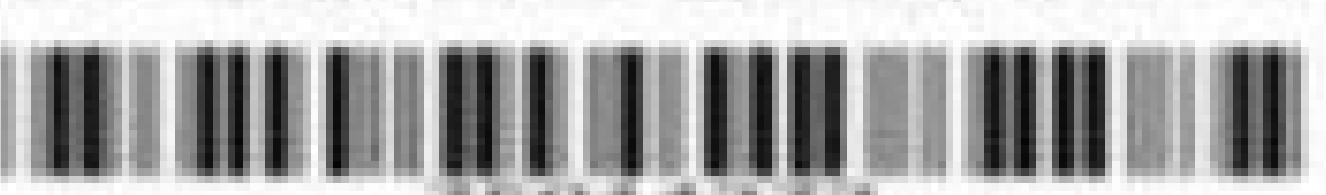
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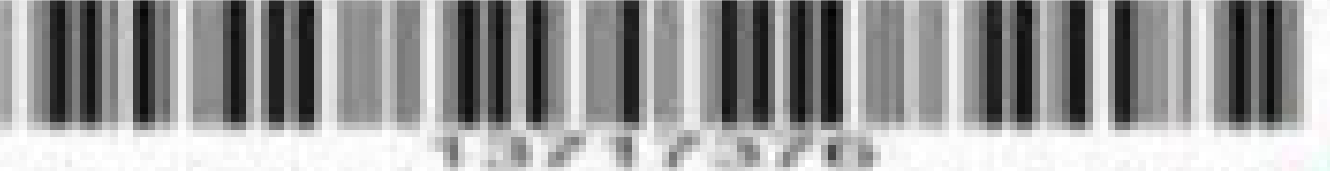
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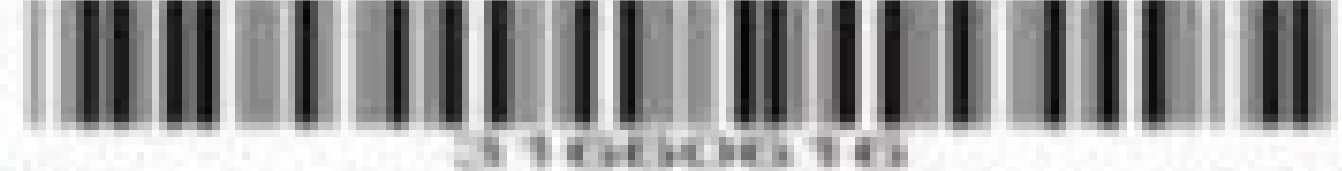
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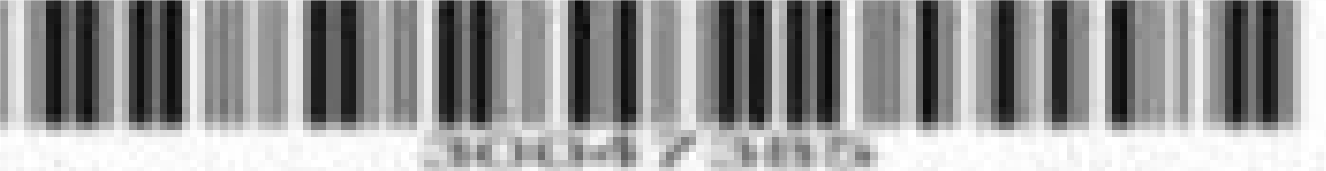
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30047385

SUPER COUPON!

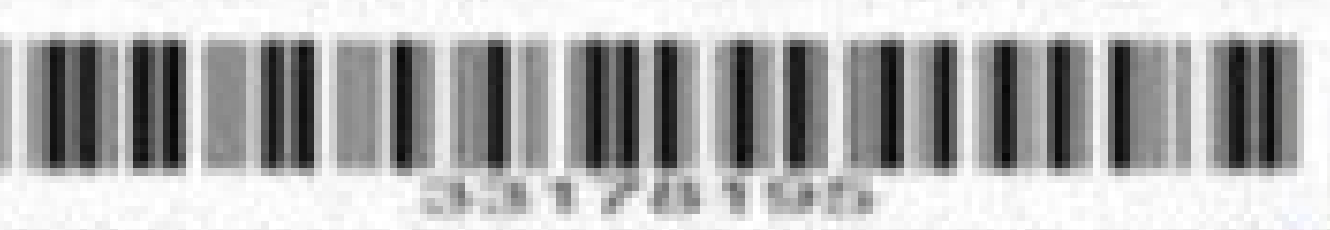
**105 PIECE
TOOL KIT**

**SAVE
46%**



LOT NO. 4030 **4 DRAWER TOOL
CHEST INCLUDED!**
\$34.99 REG. PRICE \$64.99

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33174515

SUPER COUPON!

NEW!

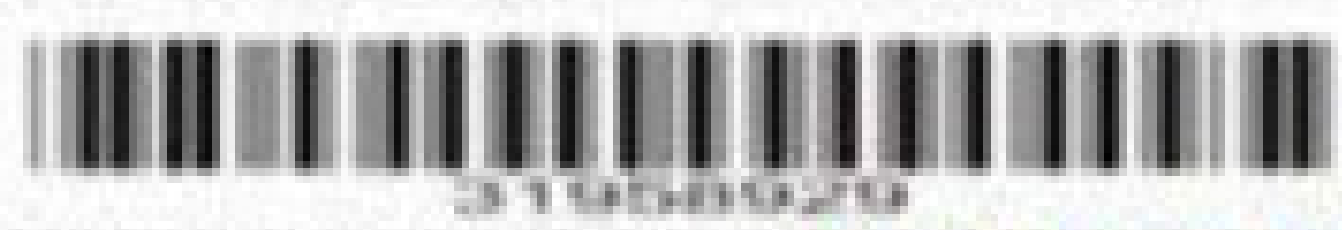
BADLAND WINCHES

**2000 LB.
ELECTRIC WINCH
WITH AUTOMATIC
LOAD-HOLDING
BRAKE**



\$49.99 REG. PRICE \$119.99 **SAVE \$70** LOT NO. 68146

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31660616

SUPER COUPON!

**OSCILLATING
MULTIFUNCTION
POWER TOOL**
LOT NO. 68303/67256



**THE PERFECT TOOL TO CUT, SAND,
SCRAPE AND SAW YOUR WAY
THROUGH ALL YOUR PROJECTS**
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45225405

SUPER COUPON!

**CENTRALPNEUMATIC
2 HP, 8 GALLON, 125 PSI
PORTABLE AIR COMPRESSOR**
LOT NO. 67501/95386



Item 67501
shown

**SAVE
\$40**
\$99.99 REG. PRICE \$139.99

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513611320

SUPER COUPON!

**CHICAGO POWER
ELECTRIC SYSTEMS**

**45 WATT
SOLAR PANEL
KIT**
LOT NO. 90599



**SAVE
\$80**
\$149.99 REG. PRICE \$229.99

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SUPER COUPON!

**800 RATED WATTS/
900 MAX WATTS
PORTABLE
GENERATOR**
**CHICAGO
Electric Generators**



LOT NO. 66619 **SAVE \$60** **\$89.99** REG. PRICE \$149.99

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60480375

SUPER COUPON!

6" DIGITAL CALIPER
PITTSBURGH
LOT NO. 47257



Includes two 1.5V button cell batteries.

SAVE 66%

\$9.99 REG. PRICE \$29.99

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26316323

SUPER COUPON!

7 FT. 4" x 9 FT. 6"
ALL PURPOSE WEATHER
RESISTANT TARP
LOT NO. 877



SAVE 50%

\$3.49 REG. PRICE \$6.99

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27880657

SUPER COUPON!

CENTRALPNEUMATIC
HIGH SPEED METAL SAW
LOT NO. 91753/113



Item 113 shown

SAVE 66%

\$9.99 REG. PRICE \$29.99

HARBOR FREIGHT TOOLS - LIMIT 9
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53729166

SUPER COUPON!

HaulMaster
MOVER'S DOLLY
LOT NO. 93888



SAVE 46%

\$7.99 REG. PRICE \$14.99

1000 LB. CAPACITY

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22020689

SUPER COUPON!

29 PIECE TITANIUM
NITRIDE COATED
DRILL BIT SET
drillmaster
LOT NO. 5889



SAVE 64%

\$9.99 REG. PRICE \$27.99

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55424873

SUPER COUPON!

drillmaster
1500 WATT DUAL
TEMPERATURE
HEAT GUN
(572°/1112°)
LOT NO. 96289



SAVE 55%

\$8.99 REG. PRICE \$19.99

HARBOR FREIGHT TOOLS - LIMIT 6
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55374920

SUPER COUPON!

LOW-PROFILE
CREEPER
LOT NO. 2745



40" 19"

300 LB. CAPACITY

SAVE 40%

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Tools sold separately.

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54355647

SUPER COUPON!

PITTSBURGH
6 PIECE
PLIERS SET
LOT NO. 38082/46005
Item 38082 shown



SAVE 40%

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SUPER COUPON!

U.S. GENERAL
BRAKE BLEEDER
AND VACUUM
PUMP KIT
LOT NO. 92474



SAVE 43%

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SUPER COUPON!

CENTRALPNEUMATIC
18 GAUGE 2-IN-1
NAILER/STAPLER
LOT NO. 68019



NEW!

SAVE 50%

\$14.99 REG. PRICE \$29.99

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SUPER COUPON!

3/8" VARIABLE SPEED
REVERSIBLE DRILL
drillmaster
LOT NO. 3670



SAVE 35%

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81033607

SUPER COUPON!

5 SPEED
DRILL PRESS
CENTRAL MACHINERY
LOT NO. 38119/44506
Item 38119 shown



\$49.99 **SAVE 44%**
REG. PRICE \$89.99

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CHICAGO WELDING
90 AMP FLUX
WIRE WELDER
LOT NO. 98871



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SUPER COUPON!

580 LB. CAPACITY
FOUR DRAWER
ROLLER CART
US*GENERAL
LOT NO. 95659



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PITTSBURGH
RAPID PUMP® 1.5 TON
ALUMINUM RACING JACK
LOT NO. 68053



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Store/Neighborhood

Homeowners Clinic

by Roy Berendsohn

Q+A



Seasonal Coverage

We have some great Adirondack chairs that my husband built, and I want to protect them with covers. I also want to

buy a cover for our new gas grill. Are these things worth the money, and will they work against the heavy overnight dew in the valley where we live? Anything left outside overnight gets soaked and stained, especially in the late summer and fall.

A Covers can provide a good deal of protection against the staining and spotting that occur after a rain or a heavy dew. To me, they'd be worth the money if they save you from having to hose the chairs off before every cookout.

As much as covers can help, you should also keep in mind that some of the moisture from the dew might condense under the cover or soak through it. That's one good reason to look for a vented cover. Not only do vents reduce condensation, but they also make it less likely that the cover will blow off. If you have to contend with really wintry winds where you live, then you're better off storing the chairs and the grills inside. If not, locate them in an area sheltered by a windbreak. Of course, that's

a good idea even if you don't cover the chairs and grill.

You haven't mentioned whether the chairs are painted or stained, but that makes a difference. Paint protects best against ultraviolet rays and the effects of weather; stains with more pigment (such as semisolids) provide the next-best level of protection, while semi-transparent and transparent stains provide the least protection.

Also, paint or a semisolid stain will fill the wood pores and provide a film that can be scrubbed clean—this is especially important if you forget to cover the chairs or if some leaves settle on them. (The tannin that leaches out of the dew-soaked leaves will stain the chairs.)

As for the grill, a cover will prevent sunlight from degrading plastic knobs, and it will keep leaf tannin from discoloring horizontal work surfaces, especially plastic ones. A cover also prevents seeds, conifer needles and leaves from getting stuck in seams between sheet-metal panels.

There is one downside to covers, though: Squirrels and other critters like to set up housekeeping underneath. So you could remove the cover in the spring and be startled by an angry, chattering varmint.

To Pull or Not to Pull ➞

Now that the weather's cooled off a little, I plan to do some landscaping that I've been putting off. I want to remove some old galvanized-steel fence posts and chain-link fence, along with some old rosebushes. Is it easier to cut off the fence posts below the ground or to pull the post and concrete? Likewise, can I cut off the bushes below the ground?

Let's start with the posts. Assuming that each post is set in a concrete footing that's below the ground surface, the easiest way to remove them is to cut the posts below the ground and leave the footing in place. To do this, you'll need a heavy-duty reciprocating saw. On a recent project, where I was digging in post footings on an urban lot, I had to cut through buried pipes, conduit and assorted auto parts. To deal with those

MEN DON'T LOOK FOR EXCUSES. THEY GET THINGS DONE.

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So if you're like millions of men who have some degree of erectile dysfunction (ED), talk to your doctor about VIAGRA. It's America's most prescribed ED treatment. VIAGRA can work in 30 to 60 minutes and, for some men, in as little as 14 minutes.*

For more information go to viagra.com or call 1-888-484-2472 (1-888-4VIAGRA).

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VIAGRA[®]
(sildenafil citrate) tablets

WITH EVERY AGE COMES RESPONSIBILITY. IMPORTANT SAFETY INFORMATION BELOW.

We know that no medicine is for everyone. Don't take VIAGRA if you take nitrates, often prescribed for chest pain, as this may cause a sudden unsafe drop in blood pressure.

Talk with your doctor first. Make sure your heart is healthy enough to have sex. If you have chest pain, nausea, or other discomforts during sex, seek medical help right away.

In the rare event of an erection lasting more than four hours, seek immediate medical help to avoid long-term injury.

In rare instances, men who take PDE5 inhibitors (oral erectile dysfunction medicines, including VIAGRA) reported a sudden decrease or loss of vision, or sudden decrease or loss of hearing. It is not possible to determine whether these events are related directly to these medicines or to other factors. If you experience any of these symptoms, stop taking PDE5 inhibitors, including VIAGRA, and call a doctor right away.

The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less common are bluish or blurred vision, or being sensitive to light. These may occur for a brief time.

VIAGRA does not protect against sexually transmitted diseases including HIV.

Take VIAGRA about one hour before you want to have sex. VIAGRA works for 4 hours. VIAGRA only works with stimulation.

Please see Important Facts for VIAGRA on the following page or visit viagra.com for full prescribing information.

*Data taken from a study of 228 men with ED who previously had success with VIAGRA. Of the 115 men who took VIAGRA 100mg, 35% had erections hard enough for successful intercourse at 14 minutes, and 51% of men at 20 minutes.

Individual results may vary.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

IMPORTANT FACTS

VIAGRA®
(sildenafil citrate) tablets

(vi-AG-rah)

IMPORTANT SAFETY INFORMATION ABOUT VIAGRA

Never take VIAGRA if you take any medicines with nitrates. This includes nitroglycerin. Your blood pressure could drop quickly. It could fall to an unsafe or life-threatening level.

ABOUT ERECTILE DYSFUNCTION (ED)

Erectile dysfunction means a man cannot get or keep an erection. Health problems, injury, or side effects of drugs may cause ED. The cause may not be known.

ABOUT VIAGRA

VIAGRA is used to treat ED in men. When you want to have sex, VIAGRA can help you get and keep an erection when you are sexually excited. You cannot get an erection just by taking the pill. Only your doctor can prescribe VIAGRA.

VIAGRA does not cure ED.

VIAGRA does not protect you or your partner from STDs (sexually transmitted diseases) or HIV. You will need to use a condom.

VIAGRA is not a hormone or an aphrodisiac.

WHO IS VIAGRA FOR?

Who should take VIAGRA?

Men who have ED and whose heart is healthy enough for sex.

Who should NOT take VIAGRA?

- If you ever take medicines with nitrates:
 - Medicines that treat chest pain (angina), such as nitroglycerin or isosorbide mononitrate or dinitrate
- If you use some street drugs, such as “poppers” (amyl nitrate or nitrite)
- If you are allergic to anything in the VIAGRA tablet

BEFORE YOU START VIAGRA

Tell your doctor if you have or ever had:

- Heart attack, abnormal heartbeats, or stroke
- Heart problems, such as heart failure, chest pain, or aortic valve narrowing
- Low or high blood pressure
- Severe vision loss
- An eye condition called retinitis pigmentosa
- Kidney or liver problems
- Blood problems, such as sickle cell anemia or leukemia
- A deformed penis, Peyronie’s disease, or an erection that lasted more than 4 hours
- Stomach ulcers or any kind of bleeding problems

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal products. Tell your doctor if you take or use:

- Medicines called alpha-blockers to treat high blood pressure or prostate problems. Your blood pressure could suddenly get too low. You could get dizzy or faint. Your doctor may start you on a lower dose of VIAGRA.
- Medicines called protease inhibitors for HIV. Your doctor may prescribe a 25 mg dose. Your doctor may limit VIAGRA to 25 mg in a 48-hour period.
- Other methods to cause erections. These include pills, injections, implants, or pumps.
- A medicine called REVATIO. VIAGRA should not be used with REVATIO as REVATIO contains sildenafil, the same medicine found in VIAGRA.

POSSIBLE SIDE EFFECTS OF VIAGRA

Side effects are mostly mild to moderate. They usually go away after a few hours. Some of these are more likely to happen with higher doses.

The most common side effects are:

- Headache
- Feeling flushed
- Upset stomach

Less common side effects are:

- Trouble telling blue and green apart or seeing a blue tinge on things
- Eyes being more sensitive to light
- Blurred vision

Rarely, a small number of men taking VIAGRA have reported these serious events:

- Having an erection that lasts more than 4 hours. If the erection is not treated right away, long-term loss of potency could occur.
- Sudden decrease or loss of sight in one or both eyes. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. They may be caused by conditions like high blood pressure or diabetes. If you have sudden vision changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Sudden decrease or loss of hearing. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. If you have sudden hearing changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Heart attack, stroke, irregular heartbeats, and death. We do not know whether these events are caused by VIAGRA or caused by other factors. Most of these happened in men who already had heart problems.

If you have any of these problems, stop VIAGRA. Call your doctor right away.

HOW TO TAKE VIAGRA

Do:

- Take VIAGRA only the way your doctor tells you. VIAGRA comes in 25 mg, 50 mg, and 100 mg tablets. Your doctor will tell you how much to take.
- If you are over 65 or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg).
- Take VIAGRA about 1 hour before you want to have sex. VIAGRA starts to work in about 30 minutes when you are sexually excited. VIAGRA lasts up to 4 hours.

Don’t:

- Do not take VIAGRA more than once a day.
- Do not take more VIAGRA than your doctor tells you. If you think you need more VIAGRA, talk with your doctor.
- Do not start or stop any other medicines before checking with your doctor.

NEED MORE INFORMATION?

- This is only a summary of important information. Ask your doctor or pharmacist for complete product information OR
- Go to www.viagra.com or call (888) 4-VIAGRA (484-2472).

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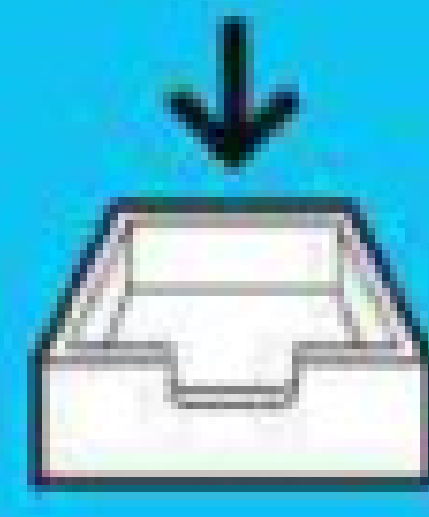
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FROM OUR READERS

TIPS, ADVICE, ANALYSIS

ADDING A DOOR

The simplest route is always the best ("Behind Door Number 1," Feb. 2011). If you can match the placement of the new outside door with a window of the same height and width, you'll have less framing to do.

JOE EDELSON, building inspector, Jacksonville, Fla.

RUNNING CABLE

While I agree with many of your tips on fishing cable through walls ("Gone Fishing," May 2010), sometimes there are other solutions. I was having trouble fishing cable in my garage while using standard fish tape. Then it hit me: I dug out some flexible tent poles, attached them together, and off I went.

TOM GRIFFIN, Elkhorn, Wisc.

CRAWLSPACE LIGHTING

It's true that working in crawlspaces is no fun ("It's Creepy and It's Spooky," March 2011). After purchasing a fixer-upper in the Fairmount National Historic District here in Fort Worth, I found myself doing considerable work in my crawlspace. To light it, I strung up half a dozen strings of Christmas lights and found they work extraordinarily well because the light they provide is so multidirectional.

THOMAS JONES, Fort Worth, Texas

cuts, I used a 15-amp Milwaukee Super Sawzall and a 12-inch bimetal blade with 14 teeth per inch. I think a similar setup would work equally well for you. When I had to cut through tree roots, I switched to a blade rated to cut wood and nails. Wear safety glasses when you're doing this work, and plug the extension cord to the saw into a ground fault circuit interrupter outlet or use an extension cord equipped with a GFCI.

But what if the posts have concrete footings even with or above the ground surface? There's no way you can cover over those, so you'll have to pull 'em. Dig an oval-shaped hole around the footing and use the post itself as a lever to work the post and footing out of the hole. You might also rig up a car jack and lift the post and footing out of the hole. And one more word of advice: I've seen many a good shovel broken trying to pry this stuff out. Instead, put the shovel aside and use the thickest digging bar you can find—preferably one that's 5 feet long, with a chisel tip.

Leftovers, Again • It's not unusual for me to have some caulk left over at the end of a project. What's the best way to save it, and how long does caulk last? I don't keep opened tubes of caulk. I'm just too fussy about this stuff, and if it means that a half-filled tube goes in the trash, so be it. I figure that if something is important enough to require caulk, then it's important enough to need fresh material, and the best stuff I can find at that. Furthermore, I'm meticulous about the surface preparation prior to caulking and the application of the caulk itself. I don't want to go through that much trouble and then use caulk that's a year or more old. The partially polymerized caulk is liable to fail long before fresh material would.

Besides, I've learned the hard way over the years that there's no sense in cluttering my already overfilled work area with junk I won't need—and that includes half-empty tubes of caulk, cans of paint that are slowly rotting away and containers of crusty drywall compound complete with a slimy layer of mold. Storing it instead of chucking it won't change the fact that all this stuff is really garbage.

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Having said that, there are times when you need to keep an open tube on hand for a few days or even a few weeks as you finish a project. I've tried everything to seal these used tubes, from big framing nails to drywall screws to little wooden wedges that I carved to shape with a utility knife. The best product that I've seen is the Twist-n-Seal plug. It's a cone-shaped piece of glass-filled nylon that you twist into the end of the tube. A five-pack costs \$4 to \$5, depending on where you buy it.

Repeating History • I'm building a shed, and I'd like it to look like the historic barns and outbuildings where I live. Is it a good idea to use metal roofing on my shed to imitate those buildings?

Sure, metal roofing would look great on your shed. There's hot-dipped galvanized steel that weathers to a dull gray, and there are metal roofing panels in pleasant shades of red and green that are coated at the factory, so you never have to paint them. "Hot-dipped," by the way, means that the steel is dipped in molten zinc. The zinc cools to form a nearly indestructible layer that increases the corrosion resistance of the steel roofing below. If the barns and outbuildings where you live have roofs that are weathered to a dull gray color, chances are good this is the roofing that was used on them.

You've got two basic choices for the roof's surface profile: One is corrugated, and the other is standing-seam. Corrugated roofing, as its name implies, looks like wavy corrugated cardboard. Standing-seam roofing consists of flat metal panels that join to one another with a short vertical rib. Most utilitarian buildings that were built by farmers used corrugated roofing.

Finally, keep in mind that condensation may form on the underside of the roof, and it may run down and drip off at the eaves. If it snows where you live, the buildup is liable to slide off the roof in one large piece or several large chunks. Consider installing snow guards

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on the roof. These barriers prevent this dangerous phenomenon by holding snow in place, or at least slowing a big chunk of snow that comes sliding down from above.

Molded Moldings • What's your opinion of polyurethane moldings? I'm thinking of dressing up my house on the inside and outside with them. How are they attached?

Well, put it this way: I'm a wood guy. Give me wood moldings and architectural trim any day. The thing is, to make wood moldings live up to their potential, you need to start with good vertical-grain lumber, properly pretreat it with paintable wood preservative (if you're installing it outside) and then prime it and paint correctly. Outside, you have to remember to prime the back as well as the front and any cut surface or end grain. You also need to use hot-dipped galvanized or stainless-steel nails or screws when installing this woodwork outdoors.

Stepping off my soapbox for a minute, I think that a good-quality polyurethane molding can look pretty nice, with a couple of exceptions. I have seen large polyurethane moldings sag over garage doors and wide window openings. I've also seen several instances outside where the factory-applied coating peels or cracks, especially where the sun beats down with intensity on the south or west face of the house. Yes, these damaged surfaces can be repaired, but they never look quite right afterward.

These moldings are glued with polyurethane construction adhesive and fastened with either drywall screws, trim-head wood screws or wood screws, depending on what the manufacturer

recommends. Fastener holes are covered with a latex filler and carefully smoothed.

Leaning Chimney • The concrete-block chimney on the side of my house is pulling away. There's a gap of about ¾ inch at the top, between the chimney wall and the house. When we purchased the house a couple of years ago, the home inspector advised us to strap the chimney to the house to keep it from toppling over. What's the best way to handle this?

I would tear the chimney down and replace it with a steel one. Yes, you could simply buy some steel flat stock, shape it around the chimney and sock it to the house frame with lag screws. That would certainly work, at least for a while. But it wouldn't do anything to address that gigantic gap that lets in water and bugs. And no, globbing tube after tube of caulk into the gap is no solution either.

Chimneys are notorious for leaning, either from their own lack of structural integrity or because they've been built on a weak footing. I'm willing to bet that an insufficient footing is at the heart of the problem. Even if you strap the chimney to the house, the chimney will continue to rotate away from the house as its footing moves. Worst-case scenario: The chimney tears off the strap and falls like a tree. It happens from time to time.

If the chimney were a nicely built brick structure, it might be worth saving. A foundation company or a masonry contractor could probably coax it back into position and repair the footing. In this case, it's easier and better just to remove it. **PM**



Got a home-maintenance or repair problem? Ask Roy about it. Send your questions to pmhomeclinic@hearst.com or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

Backyard Boardwalk

HIDDEN FASTENERS AND STAIN-FREE PLANKS ARE BRINGING NEW TECH TO THE AMERICAN HOME'S CLASSIC OUTDOOR HANGOUT.
BY HARRY SAWYERS

→ The debris piled up on a Long Island, N.Y., lawn reveals how much backyard deck construction has changed in the past 20 years. Jay Oliver, who is here to build the home's new deck, points out the rotten cedar planks, pressure-treated lumber and ring-shank nails used to fasten the two together. The nails in particular are signs that the structure was built back around the time he got started in the business.

Today, Oliver says, composites are starting to eclipse cedar and other woods as the board material of choice. And advances in preservatives and hardware have raised the expected life span of a deck to 20 or even 25 years. But some things haven't changed. Rotten ledger boards still indicate that a deck is nearing the end of its life. And using the right fasteners between the framing and the house—lag or ledger bolts, yes; common nails, *never*—is still a top priority.



THANKS TO: LONG ISLAND DECKING, PROFESSIONAL DECK BUILDER MAGAZINE, MARJAM SUPPLY COMPANY, EXTREME DECKS, FASTENMASTER, DECK RESTORATION PLUS, WEST COAST DECKS, PRINCIPAL PARTNERS

INSIDE

→ DECK BOARD BREAKDOWN →
POSTS → BEAMS → JOISTS →
FASTENER GUIDE → CLEANING TIPS
→ LEAVING ROOM FOR A TREE

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CONSTRUCTION DETAILS

HOW TO SWAB THE DECK



MUSTARD SPOT

→ Dab dry stains with wet mustard, then soapy water, Deck Restoration Plus pro Everett Abrams says.



GRILL DRIPPIN'

→ Hit grease spots with oven cleaner, soapy water and a soft brush. "Get it while it's still wet," Abrams says.



LEAF TANNIN

→ Use oxalic-acid-based wood brightener to neutralize black stains from leaves or metal furniture.

BUILDING AROUND A TREE Greg Ethenoz of Extreme Decks in Thousand Oaks, Calif., keeps framing members 8 inches from the tree trunk and uses a jigsaw to trim decking to a 4-inch distance. For safety, he adds a rim to mark the gap.

DECKING
LAG BOLTS
JOIST HANGER
LEDGER

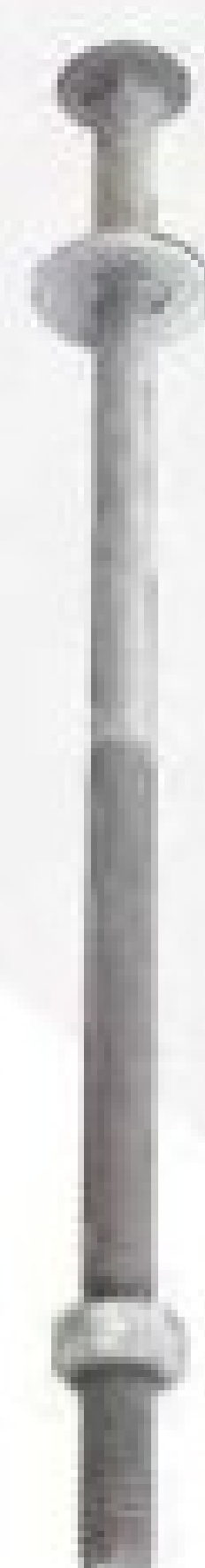
JOIST
JOIST STRAP

BEAM
RIM JOIST

FOOTING

POST

FIELD GUIDE TO FASTENERS



1/2-INCH GALVANIZED LAG BOLT

This bolt is an option to anchor the deck to the house's ledger board, and it can fasten posts to beams. Inspectors like to see threads proud of the nut.



COLOR-MATCH SCREWS

With a polymer coating to match composite deck colors, these 2 3/4-inch screws' slim heads hide the fact that they're fastened through a deck board's face.



PRESSURE-TREATED SCREW

This 2 1/2-inch coated screw resists corrosion when used with ACQ and copper azole pressure-treated lumber, as well as cedar and redwood.

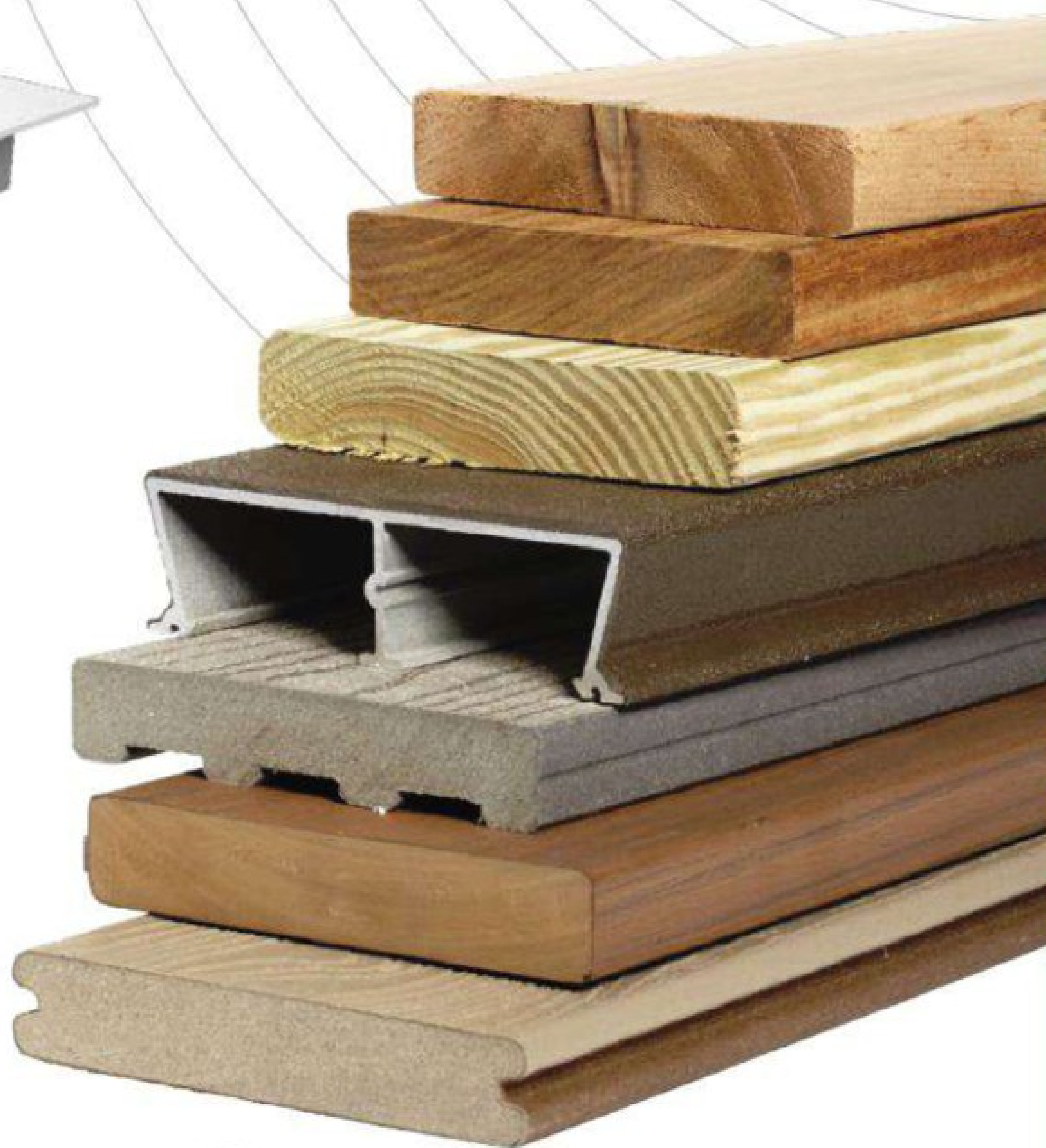
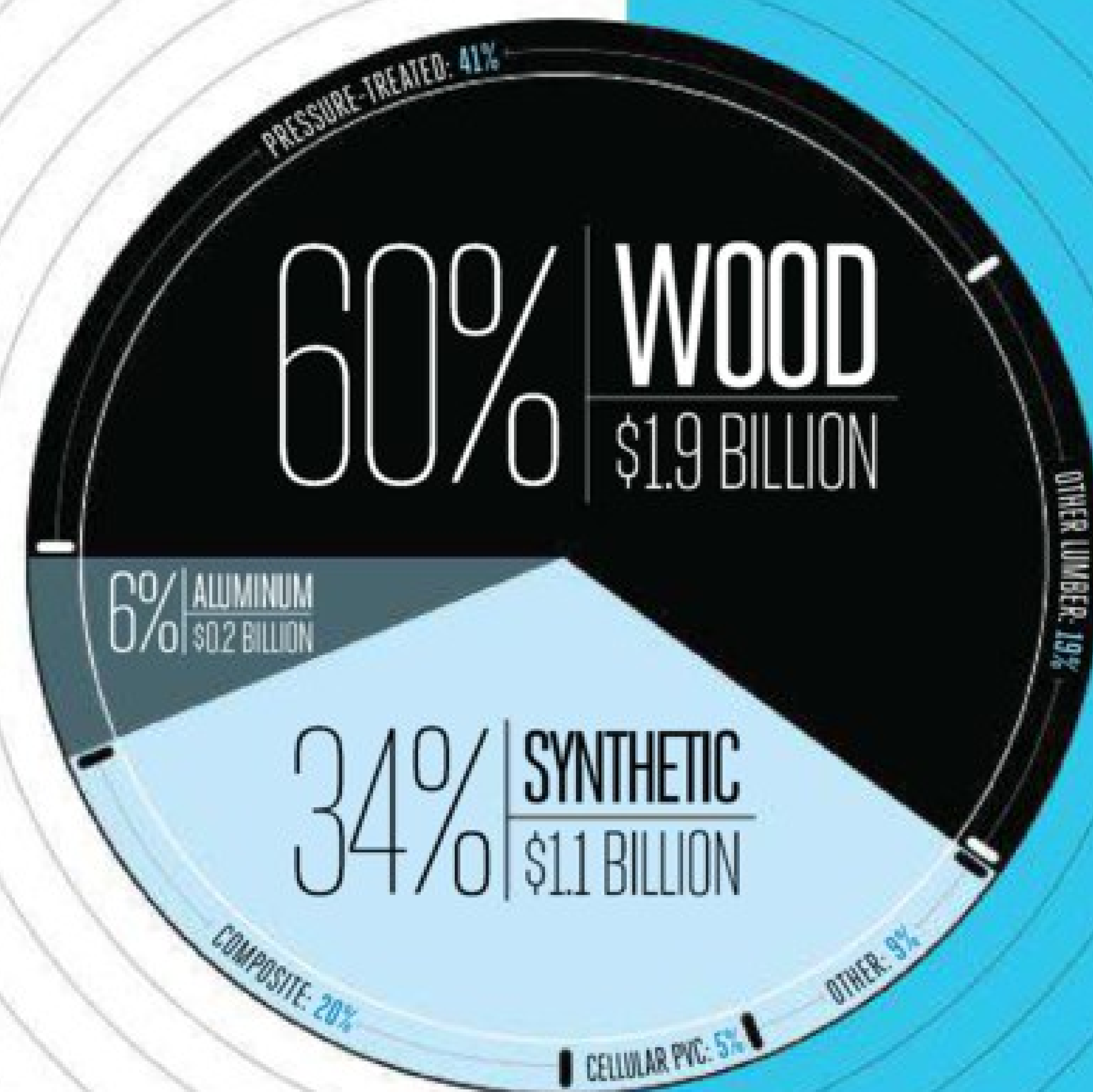


SELF-TAPPING LEDGER SCREW

FastenMaster's 5 3/8-inch LedgerLOK, rated for 25 percent more shear load than a 1/2-inch lag bolt, fastens deck framing to a house.

WOOD VS THE CHALLENGERS

→ North Americans spent \$3.2 billion on residential decking in 2010, according to a study by industry analysts Principia Partners. Synthetic products grab more market share every year, but for now, wood is still the top dog in decking materials.



CEDAR

Light and fragrant, cedar weathers to a silver gray after a year.

IPÊ

Ipê is a rot-resistant tropical hardwood.

PRESSURE-TREATED PINE

This affordable lumber is commonly used as framing and decking in the East.

VERSADECK

Aluminum decking stays surprisingly cool, even in hot sunshine.

TIMBERTECH

This company's decking blends polymers and wood flour.

AZEK

Cellular PVC decking is feathery and durable.

TREX

Like TimberTech, Trex now offers a capped composite. It resists staining and fading.

PLUG-TO-HIDE SCREW

Cortex, from FastenMaster, has a countersink bit, a screw and a plug dyed to match the color of composite decking. It hides a face-fastening job.



HIDDEN FASTENER

Screwed to a joist, this Trex fastener has tabs to slip into the grooves along the boards' edges. A similar clip called Tiger Claw debuted in 2000.



JOIST HANGER

This galvanized saddle mounts joists to rim joists or ledgers. Simpson Strong-Tie makes this hardware and connectors for beams and posts.

POST BASE

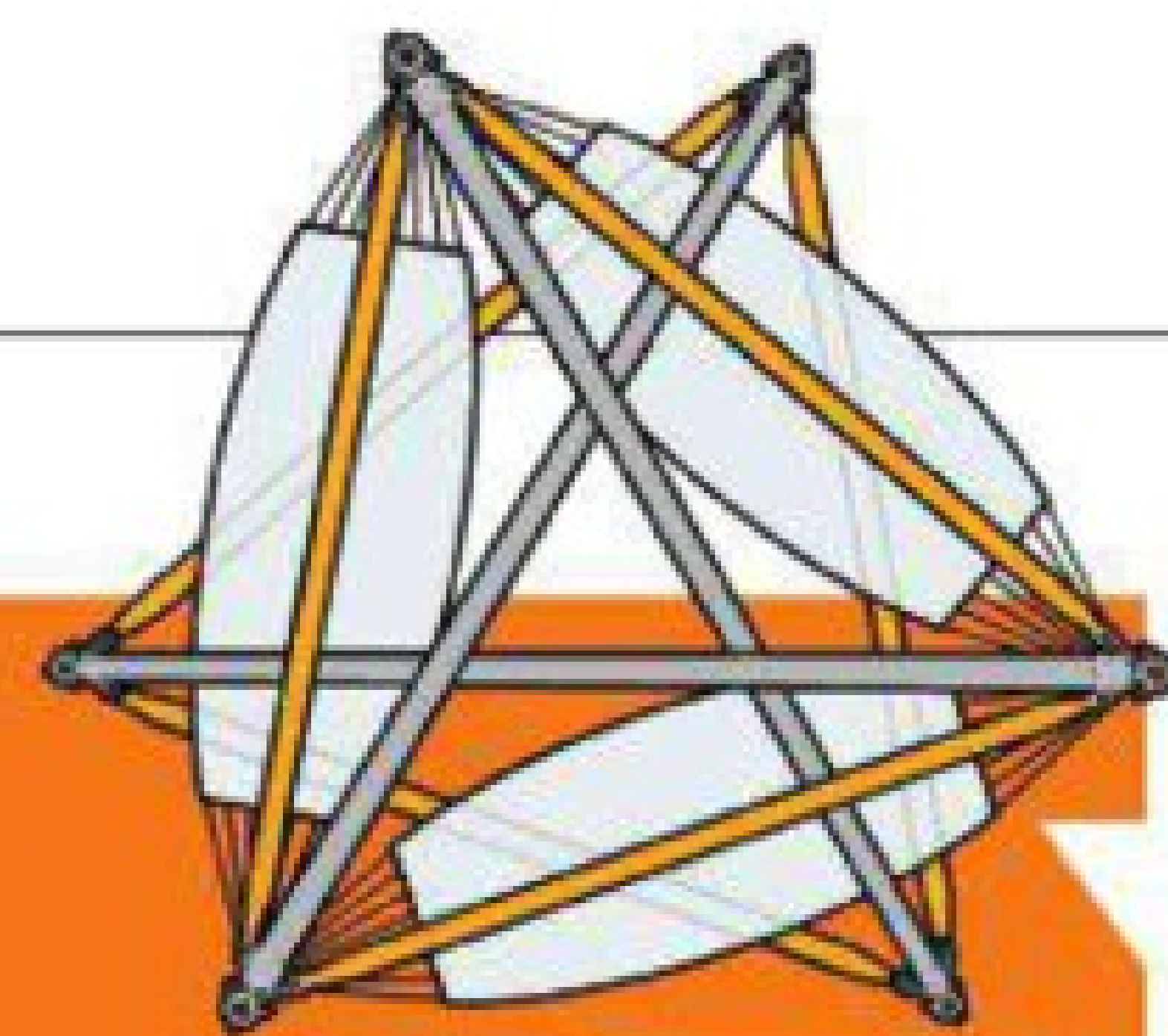
Bolts fasten a 4 x 4 post to the side walls. A machine bolt in a concrete footing enters from below, connected to the base by a nut on its tip.



Hammock of the Futurist

GEODESIC-DOME VISIONARY BUCKMINSTER FULLER BUILT EASILY ERECTED, ADAPTABLE STRUCTURES USING TENSION BELTS AND COMPRESSED RODS. HE CALLED THE IDEA TENSEGRITY. BUCKY'S IDEAS UNDERPIN THIS DIY HAMMOCK STAND.

BY WILLIAM GURSTELLE



TOP VIEW

3

ATTACH BOTTOM STRAPS

Arrange pipes on the ground in a weave pattern as shown in the top view. The pipes must overlap in exactly this way. Adjust three tie-down straps to 8 feet long. Attach each strap to the low point on the three pipe ends, forming an equilateral triangle along the ground.

1

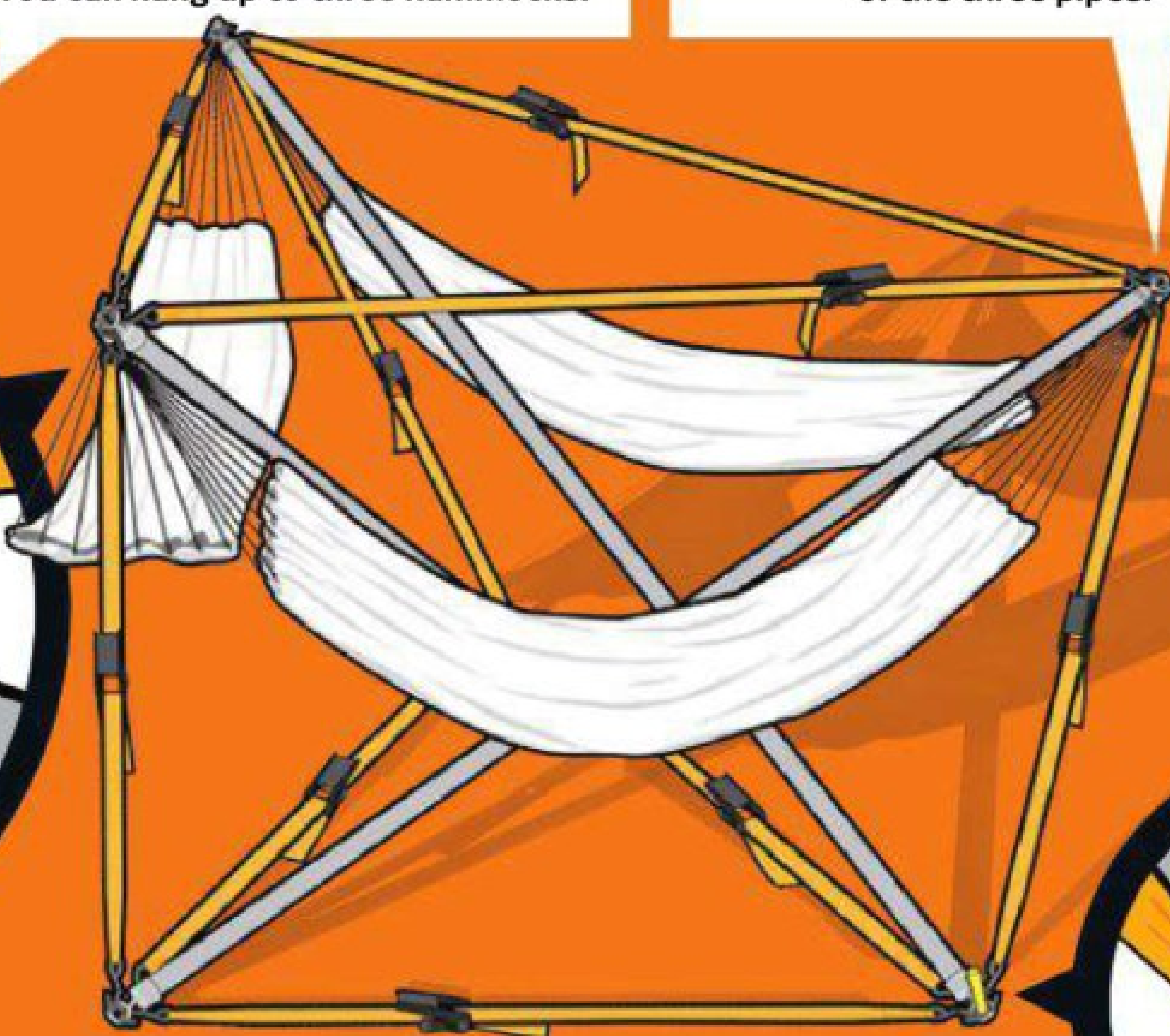
FIND PARTS

Hit the hardware store to find: three 1-inch-diameter, 10-foot galvanized steel pipes with threaded ends; six threaded 1-inch pipe caps; six $\frac{3}{8}$ -inch-diameter, 4-inch eyebolts, with $1\frac{1}{2}$ -inch eyes, nuts and lockwashers; nine ratcheting tie-down straps 12 feet long; three 18-inch ground stakes. You can hang up to three hammocks.

2

PREPARE PIPES

Drill a $\frac{3}{8}$ -inch hole in the center of each pipe cap. Insert the eyebolt and fasten it securely with a lockwasher and nuts. Screw pipe caps onto both ends of the three pipes.



4

MOUNT MORE STRAPS

Adjust three additional ratcheting tie-down straps to 12 feet long. Attach a strap to each remaining unstrapped pipe end to make the top triangle. Operate each top strap ratchet a few clicks at a time to shorten the straps. As you tighten, the structure will lift from the ground, seemingly erecting itself—it's almost magical. Stop ratcheting when the top triangle is equilateral at 8 feet per side. Take the three remaining straps and adjust each to about 7 feet long. Connect each strap end from the upper eyebolt to the lower eyebolt most directly beneath it. Operate the ratchet a few clicks at a time to tighten the straps and stabilize the structure. Don't overdo it; a bit of play is fine.

5

STAKE, NAP

The tensegrity hammock stand is freestanding, but it can tip over. Add stability and safety by staking each bottom eyebolt to the ground. Hang a hammock from any of the two top eyebolts. Use ratchets rated to handle more than the nappers' combined weight. Climb in, take a snooze, and dream of perfectly inert static equilibrium—or even geodesic domes.

+ MORE TO DO IN SEPTEMBER

Grill to Win

→ Compete with the grill masters of the Midwest at the Silver Lake Sand Dunes Apple & BBQ Cook-Off Festival Sept. 9 to 10 in Hart, Mich. Don't do pork? Hit the dune buggy showcase and swap meet.

See Boats Fly

→ Witness America's top flying-boat parade at the Glenn Curtiss Seaplane Homecoming Sept. 16 to 18 in Hammondsport, N.Y. The boat-pilot nation attends the event, named for the father of the seaplane.

Split Them Rails

→ At the 41st annual Abraham Lincoln Railsplitting Festival in Lincoln, Ill., Sept. 16 to 18, contests include corn shelling, tomahawk tossing and lariat roping. Watch pro splitters cut a log into eight rails—fast.

Buy a Car, Cheap

→ As manufacturers ship 2012 cars, dealers sell off 2011 vehicles. "That's when you'll see big savings events and lot-clearing sales," John Elway Chevrolet rep John Ford says. Haggle and get a deal!

Whip Up an Oven

→ Learn basic masonry and a thing or two about pizza during a seminar on how to build and use a 32 x 36-inch wood-fired brick oven at the North House Folk School in Grand Marais, Minn., Sept. 22 to 25.

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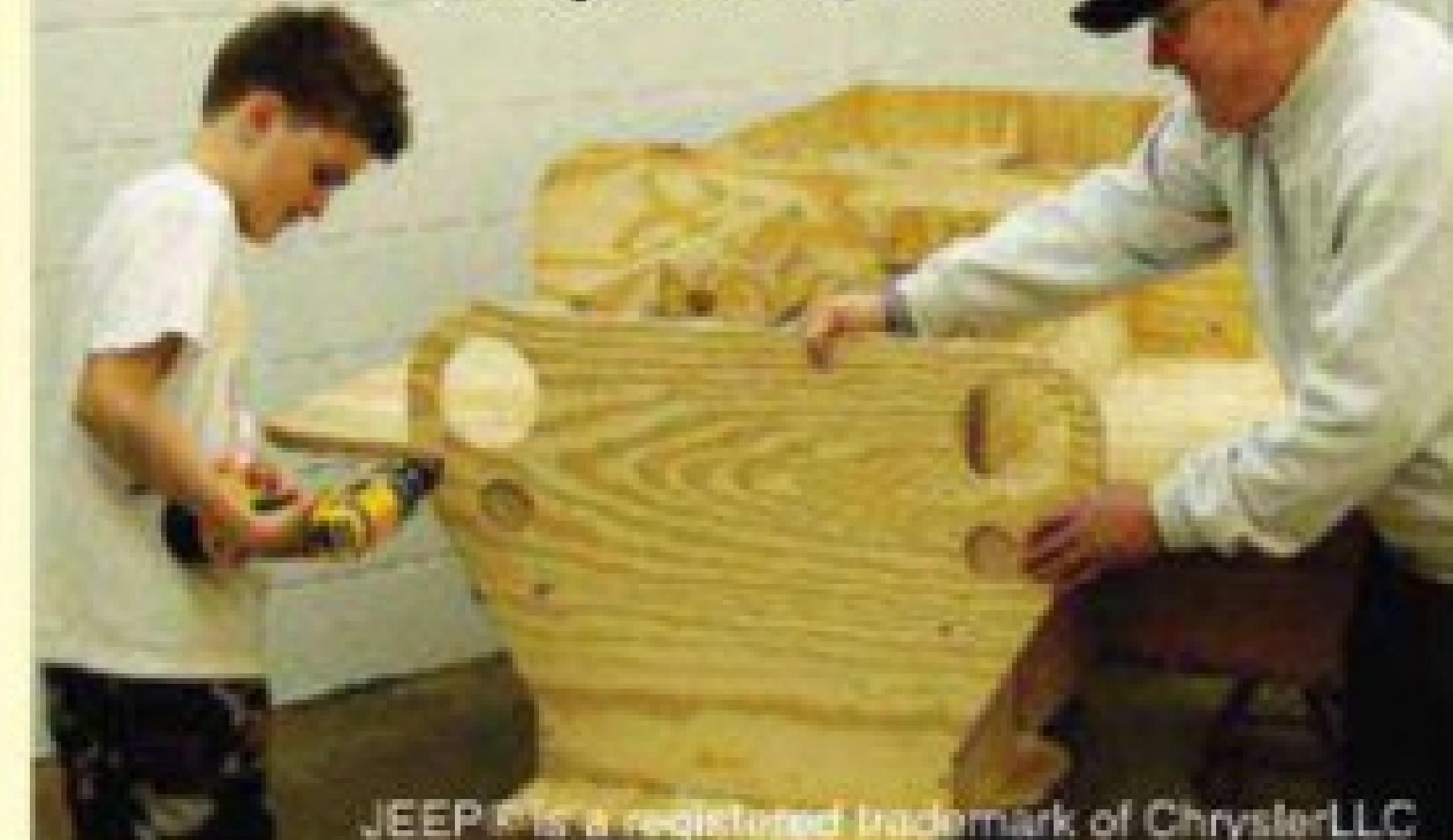
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Retapping a Stripped-Out Oil-Pan Bolt

GOT THE CROSS-THREAD BLUES? A SIMPLE, 10-MINUTE PROCESS CAN SAVE HUNDREDS OF BUCKS—AND FIX THAT LEAK PERMANENTLY. BY MIKE ALLEN

➔ While backing out of the driveway, you notice a dark spot that has formed directly beneath the engine. Man, that better be condensation from the air conditioning, you think. But rubbing the slippery, spot-forming fluid between your thumb and forefinger and glancing at the bottom of the

engine confirms the bad news: Your oil-pan drain plug is leaking. No problem—a quick tightening with a socket will fix that. You'll show that lazy quick-lube technician how to tighten a bolt . . . Well, actually, there is a problem. When you tighten the hex head of the drain plug, you feel as if you're twisting a licorice stick. The threads are stripped. Back at the quick-lube shop, the manager slathers silicone sealant on a universal drain plug and installs it. That stops the leak for 10 minutes, or about as long as it takes for you to get home and add another oil stain to your driveway.

It's time to take matters into your own hands. A perusal of the shop manual says it takes a staggering 6.7 hours to replace the oil pan. With parts costs on top of that, you think maybe there's a cheaper way . . .

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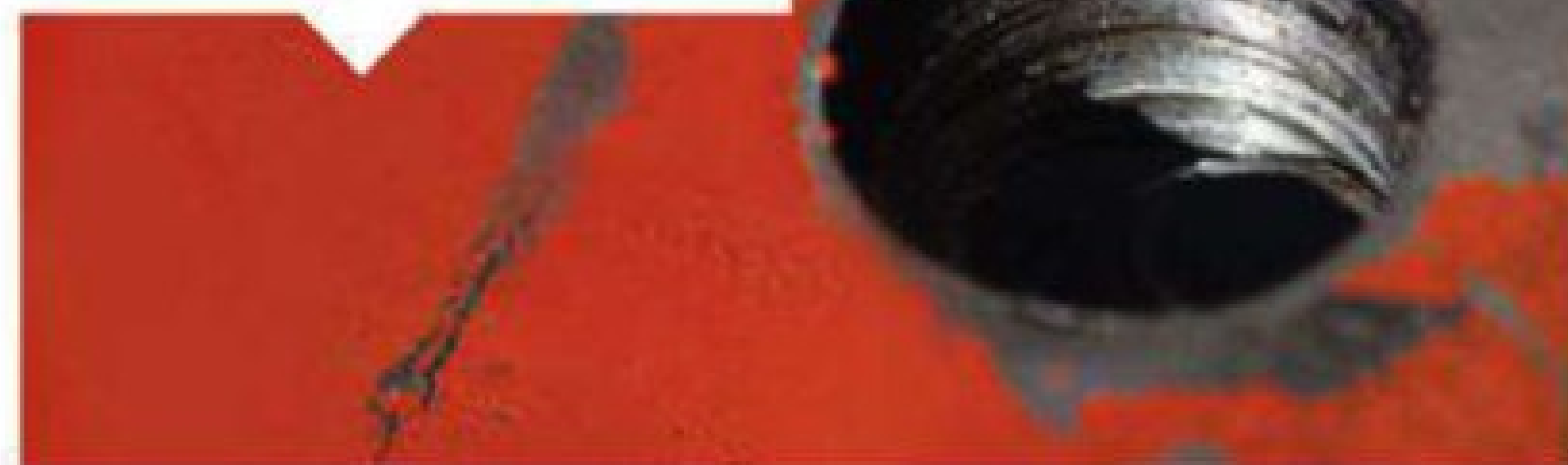
Auto OIL-PAN REPAIR

GET STARTED

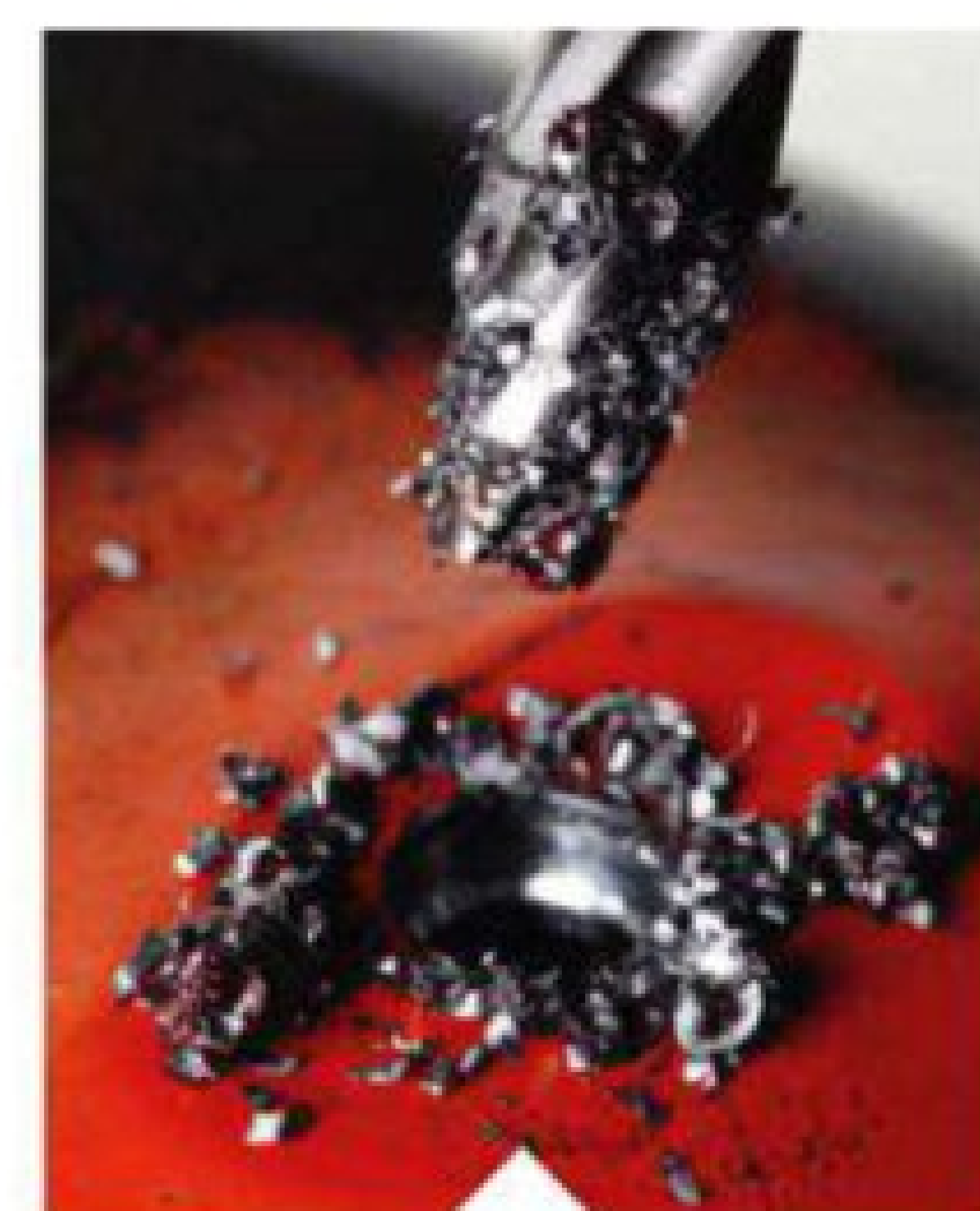


Cleaning Up the Mess

STEP 1 → Sometimes a simple thread chaser or tap will restore the threads, but these are stripped beyond redemption—done, kaput, toast.



STEP 2 → Grease (the red stuff) serves two purposes: It eases the turning and captures the metal shavings, or swarf, in the ream's flutes.



STEP 3 → After reaming through the damaged threads, withdraw the ream carefully. Most of the swarf will stick to the grease or fall to the floor. Pluck stray shavings with needle-nose pliers; don't swipe out the hole, or you'll push swarf into the pan.

STEP 4 → The ream smooths the walls of the hole; grease eases the process. (You'll be drilling up, not down, as shown in these photos.)

Make New Threads



STEP 5 → Replace the ream with the spring-loaded tap and add grease. Push on the tap's sleeve until it's square with the surface.



STEP 6 → Screw in the tap a half-turn, then back it out one quarter; repeat. This will break the chips and ensure a clean set of threads. After three or four half-turns in, unthread the tap, and clean and regrease it. Carefully work it back into the hole to resume cutting. When you're done carving the threads, the tap will move freely, as if it were an unfettered screw.

Finishing Up



STEP 7 → We used a flapper wheel on a drill to remove machining marks and loose paint. A clean surface allows the drain plug to seal well.

STEP 8 → After sanding and degreasing the surface around the hole, we applied flat-black paint, because, well, it looks cool (right).



STEP 9 → The magnetized replacement plug nabs the last of the swarf. But just to be sure, flush with 2 quarts of cheap oil before installing the plug.



STEP 10 → And now, the satisfying final step: Thread the new drain plug into the pan and tighten the bolt. Make sure it's secure—but don't put brute force into the final turn, or you may be back at square one. Yes, the whole process can be done from beneath the car!



All in One

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A The ream pilots in the old threads to give you a neat, centered hole that's square to the pan.

B The tap is spring-loaded to keep it square to the hole. Turn it with a $\frac{3}{8}$ -inch ratchet or a T-handle.

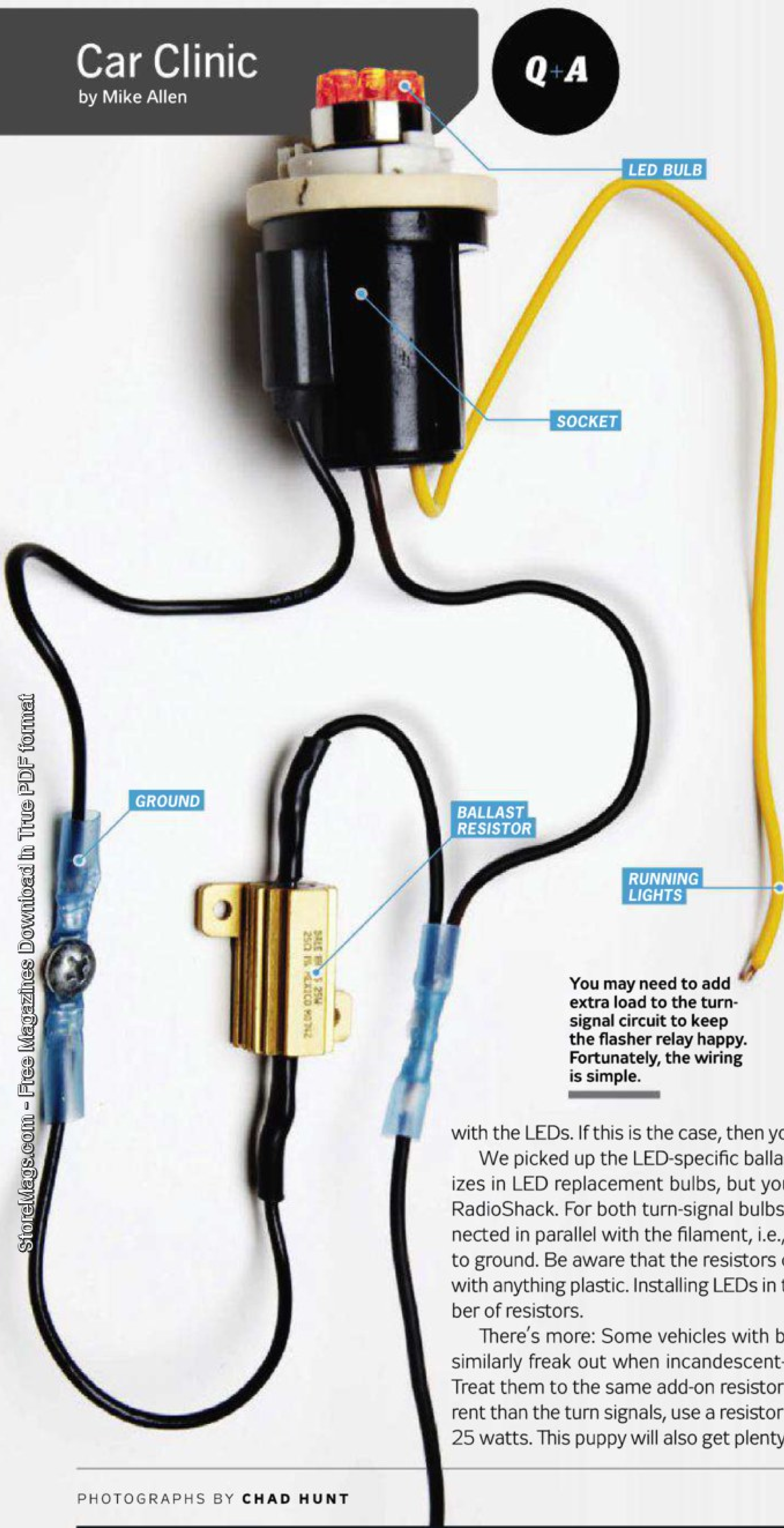
C This bushing may not be necessary to use if the pan has a raised lip around the drain plug hole.

D The drain plugs will work in steel or aluminum pans or sumps; each plug has a reusable nylon sealing washer.

Car Clinic

by Mike Allen

Q+A



Too Fast for Me

So I went to the auto parts store and bought a couple of aftermarket replacement LED taillight bulbs, because I got tired of replacing the original incandescent bulbs every two months. Now they blink about five times per second, which, as a friendly law enforcement officer has pointed out to me, is about five times too fast.

A Okay, the high flash rate is caused by the LEDs' extremely low current drain: They use far less electricity than the old-tech incandescent bulbs. Unfortunately, the turn-signal relay needs the higher current to activate properly. The light flashes like a kindergartner on Red Bull because the relay is falsely sensing a burned-out bulb. If your car uses a conventional two-pin flasher relay, you can upgrade to a heavy-duty or electronic flasher relay. That's the plug-and-play solution.

This may not be possible if you have a newfangled car with an integrated lighting module that won't play nice

with the LEDs. If this is the case, then you'll need to add some simple wiring.

We picked up the LED-specific ballast pictured here from a website that specializes in LED replacement bulbs, but you can find a perfectly acceptable version at RadioShack. For both turn-signal bulbs, you'll need a 6-ohm, 50-watt resistor, connected in parallel with the filament, i.e., one end to the 12-volt supply wire and one to ground. Be aware that the resistors can get hot, so don't mount them in contact with anything plastic. Installing LEDs in the front too? That means doubling the number of resistors.

There's more: Some vehicles with burned-out-bulb notification on the dash will similarly freak out when incandescent-light marker bulbs are replaced with LEDs. Treat them to the same add-on resistor cure. Since the marker lamps draw less current than the turn signals, use a resistor that draws less current: to wit, 25 ohms and 25 watts. This puppy will also get plenty hot, so be careful where you mount it.

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PHOTOGRAPHS BY **CHAD HUNT**

Ghost Buster 🕸 I have a 2006 2.4-liter turbo convertible and my Check Engine light is on. The trouble code is P0303. Recently I've changed the spark plugs, wires, coil pack, front and rear oxygen sensors, and air filter. I also cleaned the fuel injectors, ran a tank of high-octane fuel and made sure the gas cap was tight. Finally, I installed new tires and balanced the wheels. I took it to the shop, and they did a smoke test for intake leaks. They had the car for two full days and reset the computer. Two days later the engine light illuminated again and the code was the same—P0303. I love my car, except for this ghost haunting it. It has only 49,800 miles, so I know there's a lot of life left in the car; by the same token, I don't want to spend a fortune chasing a ghost I'll never be able to find. **Do I need a catalytic converter?**

You've neglected to mention your car's make and model, information that usually makes my task much simpler. Fortunately, all cars since 1996 share the basic codes: A P0303 is a misfire on cylinder No. 3. Changing the plugs, wires and coils and cleaning the fuel injectors could have cleared that up. The new tires and wheel balancing are unrelated to the unfriendly ghost, so while it's nice that you have fresh rubber, that's not going to scare away the problem. (Please, stop me before I drive this metaphor into the ground!)

You—or actually, your shop—seems to have been pretty thorough about looking for ignition and fuel-injection issues. So I'm thinking it's time to turn your attention to mechanical issues, starting with a valve adjustment. While your car (whatever it is) may not call for periodic valve adjustments according to the codified maintenance schedule, a tight valve could cause a recurrent misfire. While the cam cover is off, check for broken valve springs and worn valve guides. If everything appears in good order, do compression or leak-down tests. The compression readings among all the cylinders should be within 10 percent, while the leak-down differentials should be within a couple percent (and certainly no more than 5 percent) of each other.

If those tests don't ferret out the issue, look for a bad exhaust gas recirculation (EGR) valve, especially if the EGR outlet into the manifold is anywhere near the intake runner to cylinder No. 3. If the EGR is leaking exhaust into the manifold when it's not supposed to, that may be the cause of the mysterious (spooky?) misfire. This last one is a long shot, because a bad EGR should set a different code than P0303.

Bugged by Synthetics 🕸 This has been bugging me for a while: Why is there no synthetic gasoline, when there is synthetic lubricating oil?

Ah, but there is such a thing as synthetic gasoline—and even synthetic diesel fuel. There are several synthetic-fuel plants worldwide that make commercial quantities of diesel from coal or natural gas. The German military made a lot of synthetic diesel and aviation gasoline during World War II when they couldn't source any petroleum. One advantage today is that "syndiesel" is totally free of the sulfur common in North American mineral petroleum. In fact, syndiesel is sometimes blended with conventional high-sulfur diesel so the resulting fuel meets current mandated ultra-low sulfur levels. (The sulfur contaminates catalytic converters.)

You might ask: Why don't we just make more syngas and syndiesel and tell OPEC to buzz off? The answer is that it's expensive—although with the current price of crude hovering at more than \$100 per barrel, the syngas may become almost profitable after a costly reforming plant is built. There are some petroleum producers who are building syngas plants, but they're betting lots of money that the price of crude will stay at stratospheric levels. Ultimately, the starting point—coal or methane—is also a nonrenewable resource and contains plenty of carbon, some of which gets turned back into the atmosphere during processing as our old nemesis, carbon dioxide. One Department of Energy study I found suggests that the carbon output of a vehicle using synthetic fuel is nearly double that of a petroleum-based fuel. The need for relatively small quantities of sulfur-free diesel makes those plants viable

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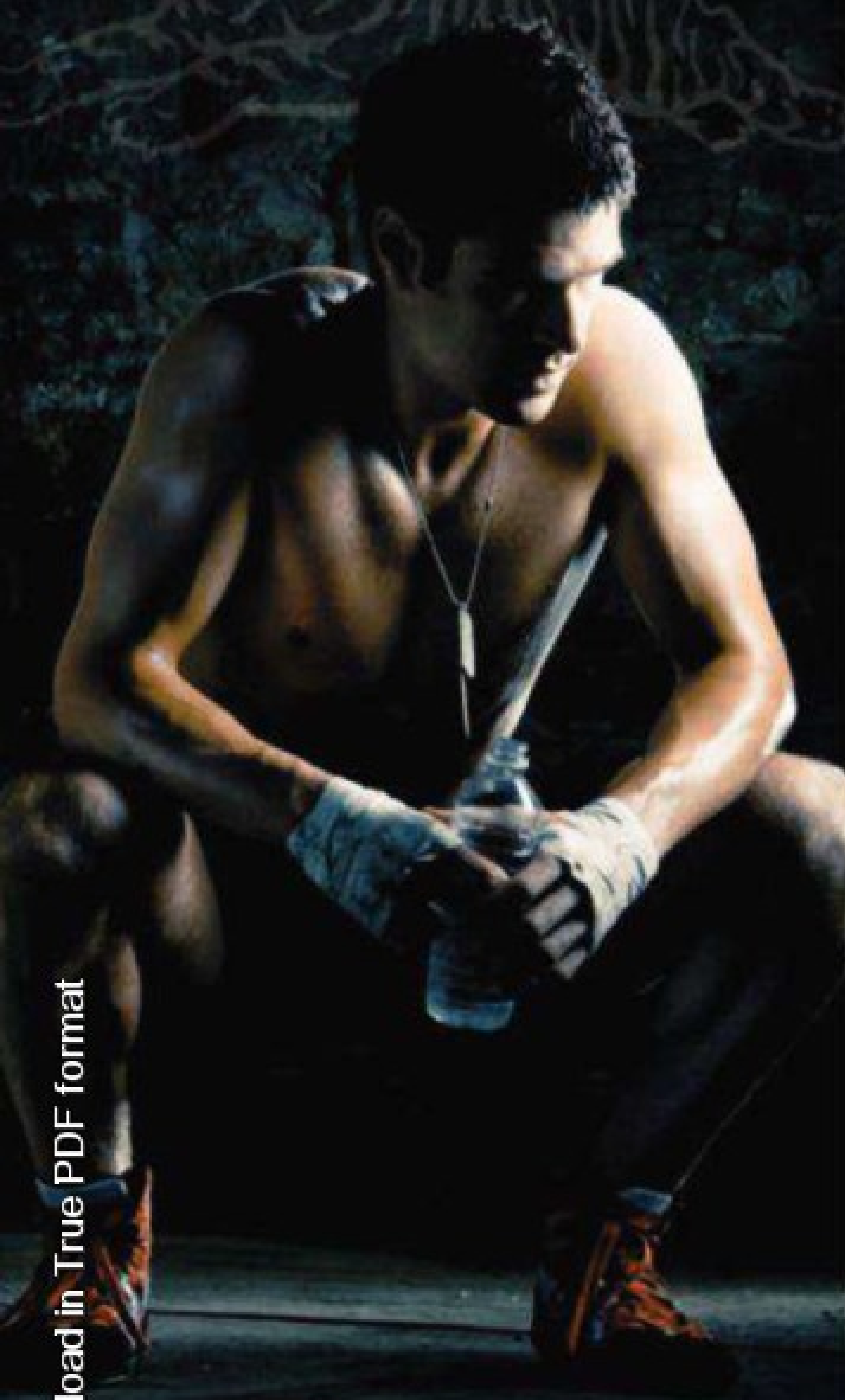
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DIY Auto CAR CLINIC Q+A

right now, but sulfur-free synthetic gasoline isn't necessary to meet EPA requirements. Add in the fact that syndiesel is easier and more efficient (read: cheaper) to make than syngas, and there's really no incentive to make significant commercial quantities of syngas—yet.

Keep Looking ➔ I replaced both upstream O₂ sensors in my 2002 Chevy Silverado. I disconnected the battery to reset the computer, but the engine light keeps coming back on. I replaced the parts again, and it still comes up with codes P0135 and P0155. What should I do? I needed to get it to pass a smog inspection two months ago. Help me, please!

Your two trouble codes, which I assume you sniffed out with a code scout or a scan tool, are indeed for the oxygen sensors. But you need to dig deeper into the meaning of the codes. P0135 and P0155 refer to the front (upstream) oxygen sensors, which—as you note—you've already replaced twice. But the code is for the heaters inside the sensors, not necessarily for the ability of the sensors to tell the engine computer if the truck is running lean or rich.

Oxygen sensors act like small batteries. In a low-oxygen environment (where the air-to-fuel ratio is rich and all available O₂ is burned), the sensors generate 800 to 900 millivolts; when the A/F ratio is leaner and there's excess O₂ in the exhaust, they create 100 to 200 mv. The engine-management computer constantly dithers the fuel mixture between slightly too lean and slightly too rich to keep the oxygen sensor crossing past 500 mv as rapidly as several times a second. That's called cross-count, and when it's properly calibrated, it keeps your engine producing good power and the least possible amount of pollution.

Here's where it gets a little complicated. The sensors operate only when they're at several hundred degrees Fahrenheit. They have small electrical heaters to shorten their warmup time and get the computer the information it needs to adjust the fuel

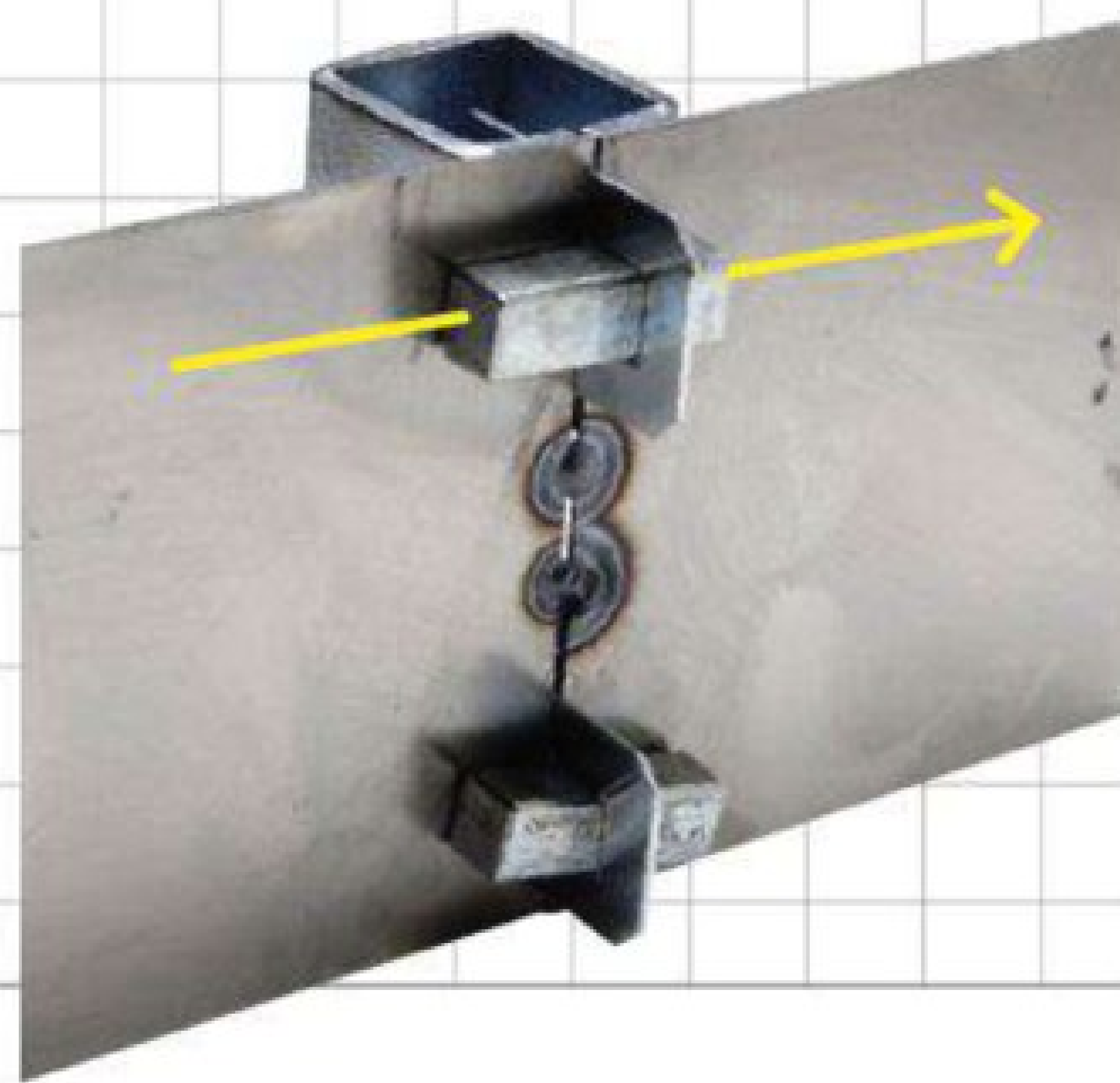
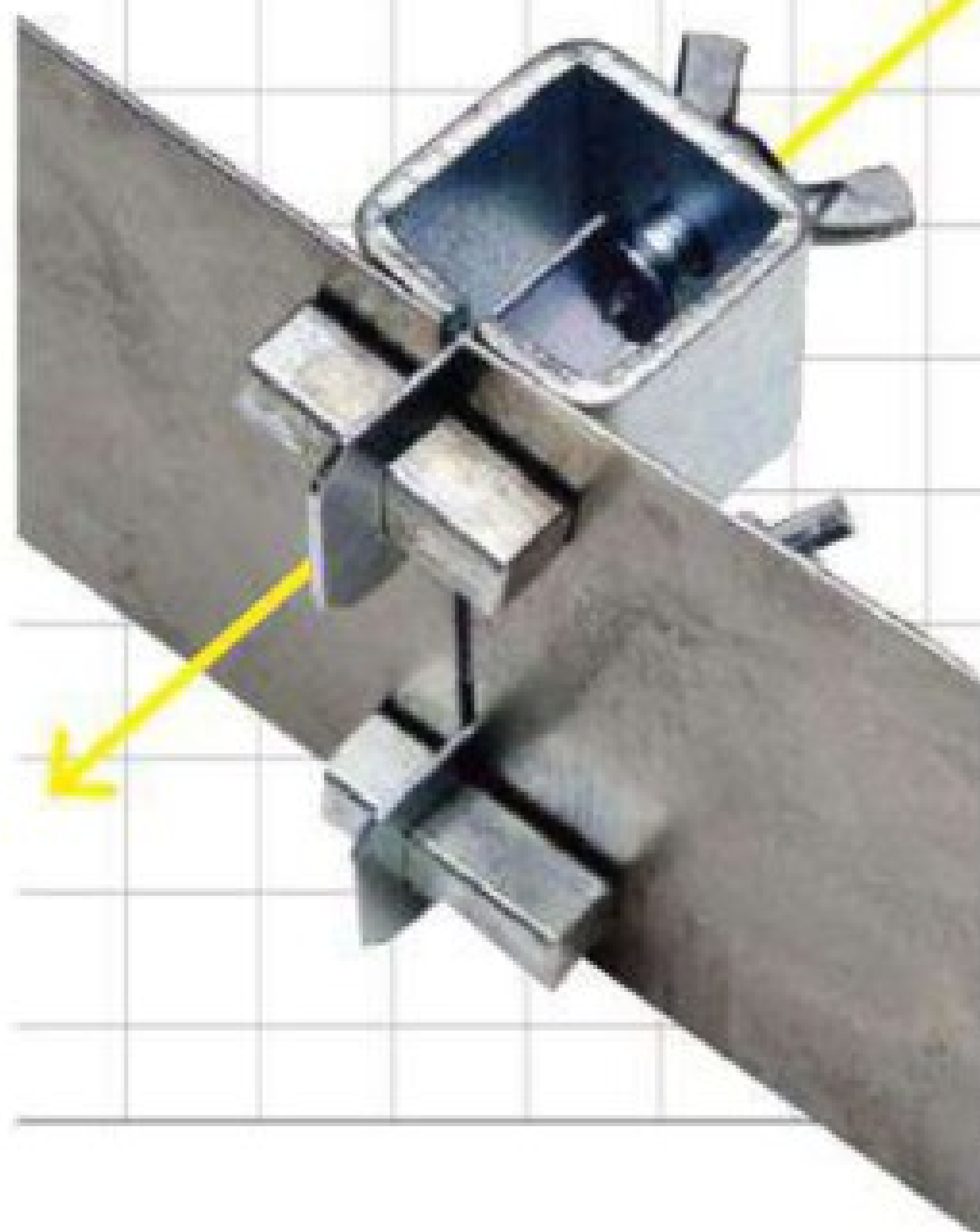


MIKE'S TOOLBOX

BUTT OUT

➔ There's a right way and several wrong ways to patch a rusted-out fender, some of which involve flattened-out Foster's Lager cans. (You know who you are.) But the only really appropriate way is to butt-weld a neatly trimmed patch into the hole in the sheet steel. A lap weld will leave a lip that has to be disguised with plastic filler, and

a crevice to collect moisture and then rust. We use these **welding clamps from Eastwood** (eastwood.com) to position the patches while we make a couple of tack welds, then remove the clamps to make a neat seam weld. The gap is exactly the right width to ensure full penetration.



mixture properly. While the exhaust will eventually heat up the sensors, that takes too long to meet emissions regulations. The engine computer monitors the oxygen sensor cross-count, and when it takes too long from a cold start for them to start operating properly, it throws a trouble code and turns on the Check Engine light.

Ultimately, I suspect you may have a problem with your heater's power circuits. Check fuses 02A and 02B under the hood; they're for the heaters. Fuses check okay? Start further diagnosis with a voltmeter between pin D of the sensor's four-pin socket (on your truck, that's the pink wire) and a good chassis ground. Turn the key: Your meter should read 12 v. If not, check the harness between the fuse block and the sensors. If you have 12 volts feeding both sensors, I suspect a bad ground connection between the sensor's heater and the engine block. In fact, since this ground connection is the *only single common point of the circuit for both sensors*, I put it high on my list of failure options. Measure the voltage between the sensor's pin C (black) wire and the engine block. The meter should read zero. If you see 12 v, it's because the ground side of the heater circuit is open. Repair the wiring.

Warning: Other vehicles use different color coding for the wires and the pin designations on the connector; do your homework if you're diagnosing another vehicle.

The Heat's Always On

➔ I have a 2005 Ford F-350 with heated mirrors. The problem is that the heaters are on all the time, and I would like to be able to shut them off. The trouble starts when it rains and the heaters start baking road film onto the surface of the mirrors, rendering them virtually worthless. Is there a way I can install an on/off switch without disabling any other

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Auto CAR CLINIC Q+A

functions of the dash or any other part of the vehicle?

The mirror heaters are supposed to switch on simultaneously with the activation of the rear-window defroster grid. (The heaters and the defroster are powered by the same relay.) Is the rear-window defroster on full time? If not, the wires to the mirror heaters are shorted to a wire that's hot, or they're miswired.

Fob Crazy I recently purchased a used 2005 Ford F-250. I have a fob controller for unlocking the doors, but I have noticed that the fobs given to me at purchase are aftermarket, not OEM Ford issue. I have also noticed that I have no theft-deterrent light blinking on my dash. Can that system be disabled and a regular key work? I received a Carfax report, and it doesn't show any theft record, but it does show a repossession. I called Ford, and they suggested taking the truck to the dealer, which I cannot afford to do at this time.

I think you've answered your own question. The repo agent had access to the Vehicle Identification Number from the credit agency, and could have legitimately used it to have a key cut by a locksmith. The original fobs are probably still with the unfortunate

previous owner. Without those, it's difficult to program new fobs properly. So, yes, the theft system has probably been disabled because it wouldn't play nice with the third-party fobs. Sorry to say, but you'll have to go to a Ford dealer—or a really good auto electric shop—to sort this out.

PM

Got a car problem?

Ask Mike about it. Send your questions to pmautoclinic@hearst.com or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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Area 51

(CONTINUED FROM PAGE 87)

what journalists write, but I stand by everything I wrote in the book," she said. She added that she'd met with Mr. X since the book came out, and that he was "clear on everything I've written."

• • •

None of the foregoing should be taken to mean that the text preceding *Area 51*'s big finish is free of kinks. For one thing, the Soviet flying-saucer story is not restricted to seven pages: The groundwork for it is laid throughout the preceding narrative, beginning on page 4. And the sections that do pass for straight history include material about nuclear tests that took place in the Nevada desert, but not at Area 51; the secret base had nothing to do with them.

What's more, the straight history, nuke and Area 51 stuff alike, is sprinkled with errors. A 1957 nuclear safety test is labeled the first of its kind (page 111), when four similar tests had occurred in 1955 and 1956, according to the U.S. Department of Energy. The same test is described as research into "the dirty bomb menace" that "posed a growing threat to the internal security of the country" (page 100), when it was really aimed at collecting data on the extent of nuclear contamination that would result if the detonating charge failed to cause an atomic explosion—again, according to the DOE.

That's just a sampling of the 35 errors that Peter Merlin found in the book. Perhaps the biggest mistake appears on the dust jacket and again in the prologue, where Jacobsen says "the U.S. government has never admitted [Area 51] exists." In truth, various agencies have acknowledged the base's existence. Evidence can easily be found on the Web, where links abound to January 1996 news-conference footage, captured by KTNV-TV, the ABC affiliate in Las Vegas, of then defense secretary William Perry. "We do have a military operation going on at Groom Lake, highly classified and highly important to U.S. security," he says. Also, in the mid-1990s, federal lawsuits brought by former workers from the area alleging that

they'd been exposed to hazardous waste on the job forced President Bill Clinton to acknowledge the "Air Force's operating location near Groom Lake." Ultimately, the base's presence has been an open secret from the start. Merlin has turned up government maps, none secret, bearing the "51" or "Area 51" designation. And in May 1955, the AEC's Las Vegas field office issued a press release announcing its construction.

A month after the book's publication, we traded email with John Parsley, the Little, Brown and Company editor who handled *Area 51*. He did not answer some of our questions: on whether he knew Mr. X's identity; on his (Parsley's) methodology in deciding whether an unnamed source is reliable; and on whether he took a role in corroborating the book's assertions or left that to Jacobsen. (As the company's executive director of publicity, Nicole Dewey, explained: "We do not, as a matter of policy, disclose legal vetting procedures and policies.") "Annie is a seasoned and well-respected journalist, and I'm fully confident in all of her reporting," Parsley said. "The book always promised to

be a groundbreaking work on a fascinating place, and it is—just as it is a tribute to each man who worked on his particular part of the base."

"Tribute" isn't the word some Roadrunners use to describe the book, and, as it happens, we ran across something that made pieces of the saucer-teen yarn seem not so groundbreaking, either. The July 1956 edition of the magazine *Astounding Science Fiction* contains a short story by James Blish, a fairly popular writer in his day. "Tomb Tapper" is about a strange craft that crashes in a small town in upstate New York, and that might be extraterrestrial; the people who find it can't tell whether it's Soviet or from outer space.

They break into the hull to find the pilot, dying in the cockpit. The pilot's helmet falls off. Lying before them is a blond-haired girl, maybe 8 years old.

To be sure, any similarity to the account of Jacobsen's unnamed source is coincidental, because Blish's story is fiction. It's fantasy. And as Jacobsen states on *Area 51*'s cover: "This book is a work of nonfiction. The stories I tell in this narrative are real." **PM**

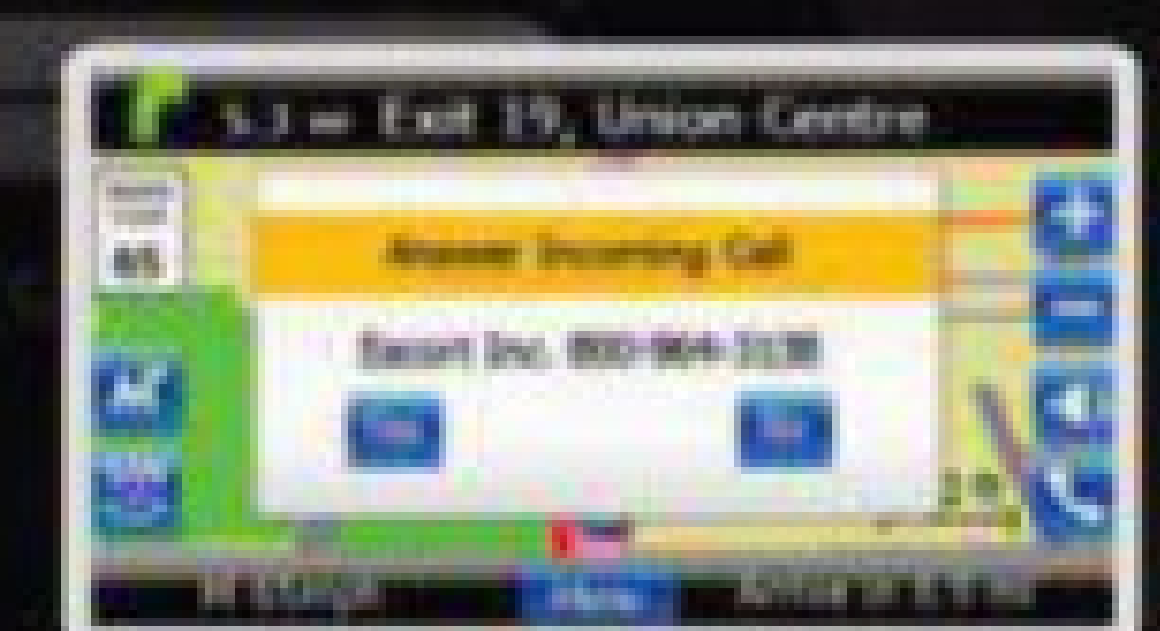
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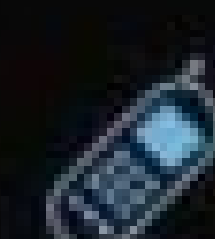


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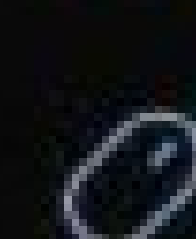
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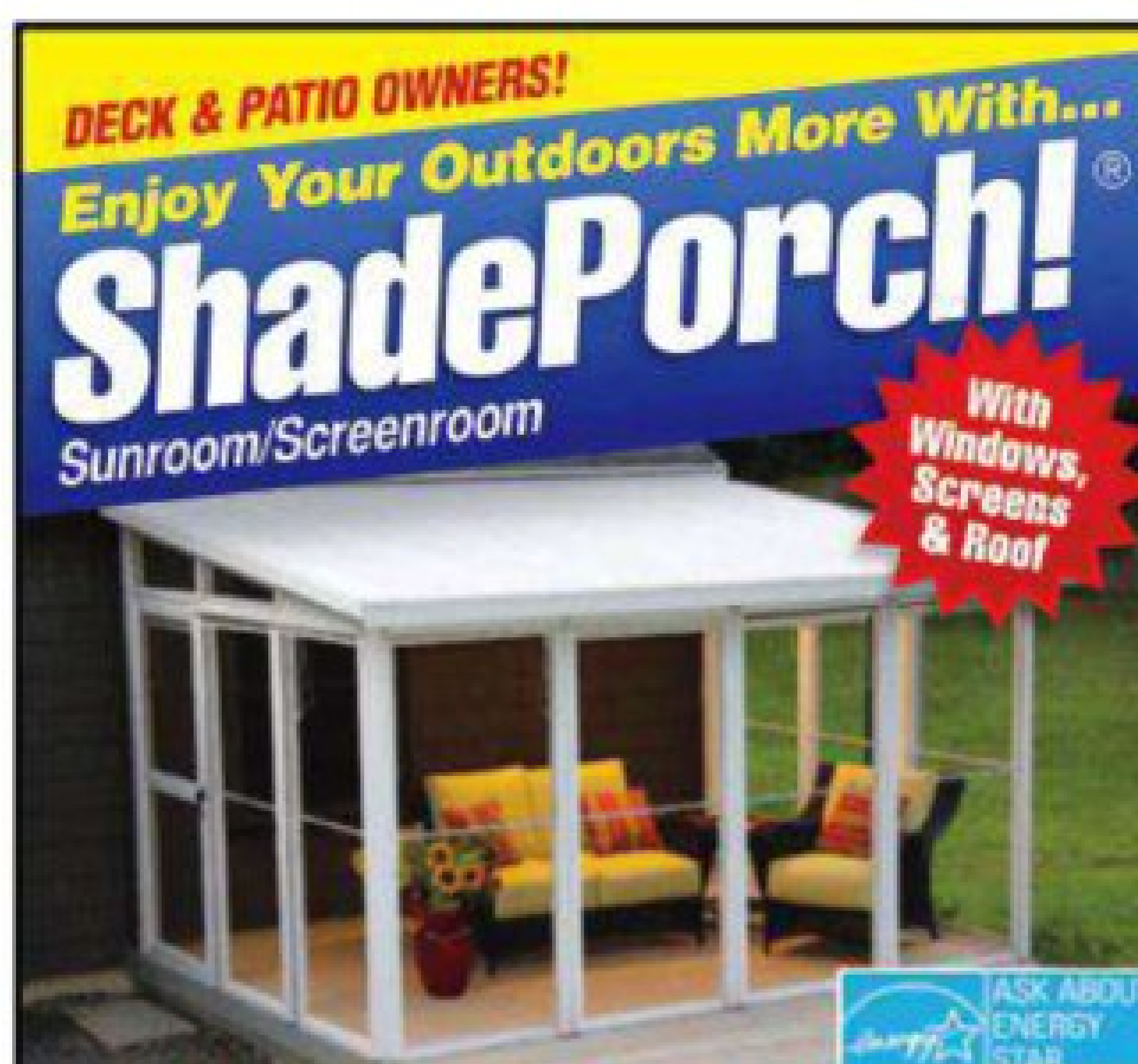
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Name: JAMES DUNLOP Location: UPTON, N.Y.
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WHAT DUNLOP STUDIES:

SPIN

→ Protons spin. So do the quarks and gluons that constitute them. But scientists don't understand how the subatomic particles' rotations contribute to the spin of the proton. To figure it out, Dunlop runs proton beams through a magnet that makes nearly all of the protons spin in the same direction. When the beams collide, splashes of quarks and gluons bounce off into the detector. The number, shape and direction of the sprays tell him the directions in which the subparticles were rotating. Understanding how these spins make the proton rotate could advance electronics that use spin to store information.

QUARK-GLUON PLASMA

→ When you add heat to ice, it melts. Add more heat and it turns to gas. But what happens when you add 4 trillion degrees C? Dunlop wants to know how matter behaves under conditions similar to those one microsecond after the big bang. "You're melting normal matter," he says, "and breaking down the protons into quarks and gluons." After clouds of protons collided inside the STAR detector, the stripped-off quarks and gluons created a plasma that, rather than acting like a gas, acted like a superfluid: a liquid with almost no stickiness. Previously, superfluids had been created only at extremely low temperatures.

STRING THEORY

→ String theory, which claims the universe is made of tiny vibrating strings and multiple dimensions, is said to be impossible to confirm. But Dunlop's team put the theory's predictions to the test when they created the quark-gluon plasma. While standard theories stated the plasma would be gas-like, string theory calculated it would be a slippery fluid. Dunlop is now pitting the theories against one another for a rematch, this time investigating how a quark slows down as it passes through the plasma.

× **James Dunlop re-creates the big bang.** At Brookhaven National Laboratory, he uses the electric fields of a particle accelerator to speed up gold nuclei racing around a 2.4-mile-long track. When the nuclei, guided by the accelerator's powerful magnets, reach 99.9995 percent of the speed of light, Dunlop makes them collide. Each 4 trillion degree Celsius crash shatters the gold particles into quarks and gluons, the tiniest building blocks of a proton. The accelerator's STAR detector, above, photographs the atomic bits and pieces, allowing him to study matter at its most fundamental level. It's not just a desk job, either. "There's also a component when you're going out to the detector with a soldering iron or a roll of duct tape," Dunlop says. "You've just got to make it work." — SARAH FECHT

PHOTOGRAPH BY NATHAN PERKEL



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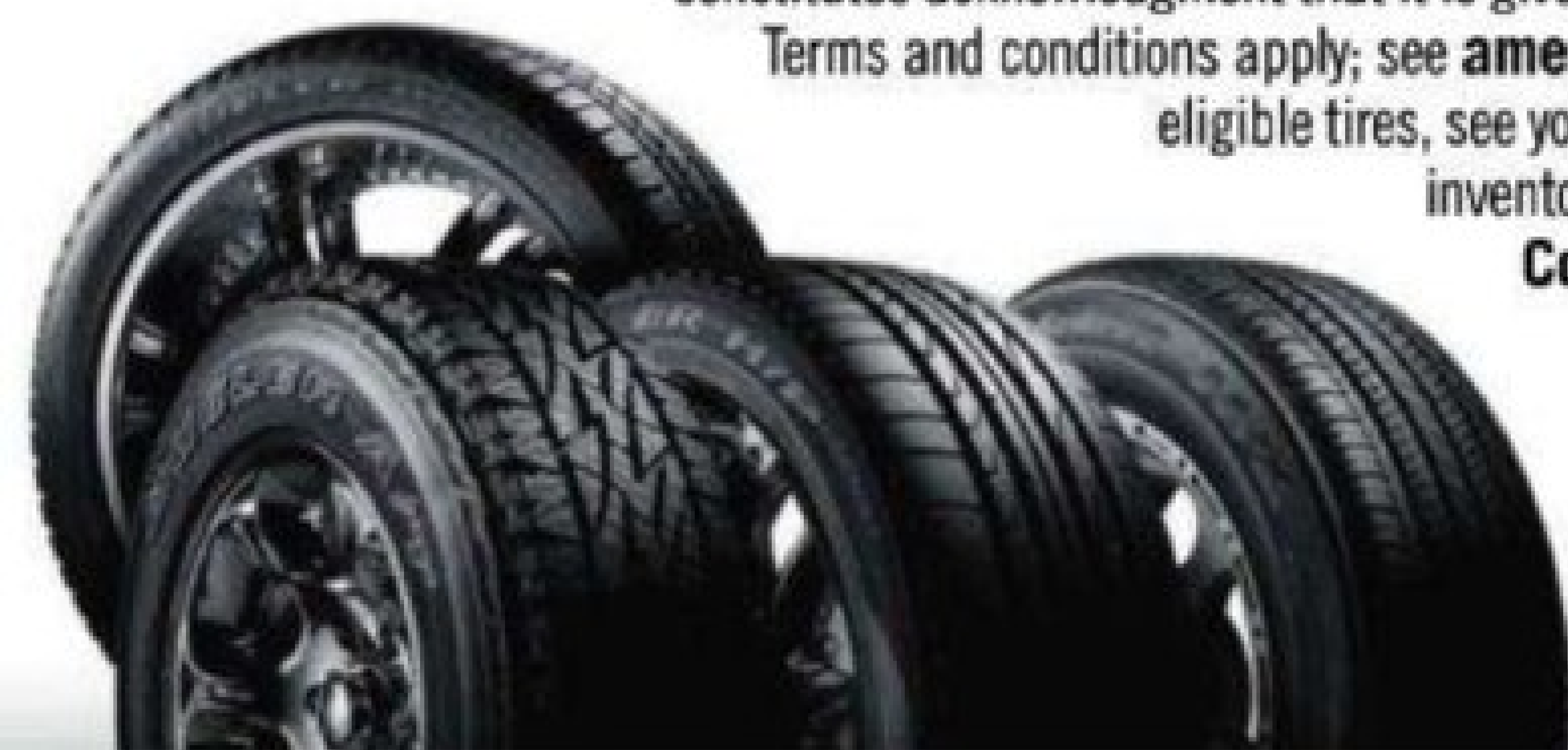
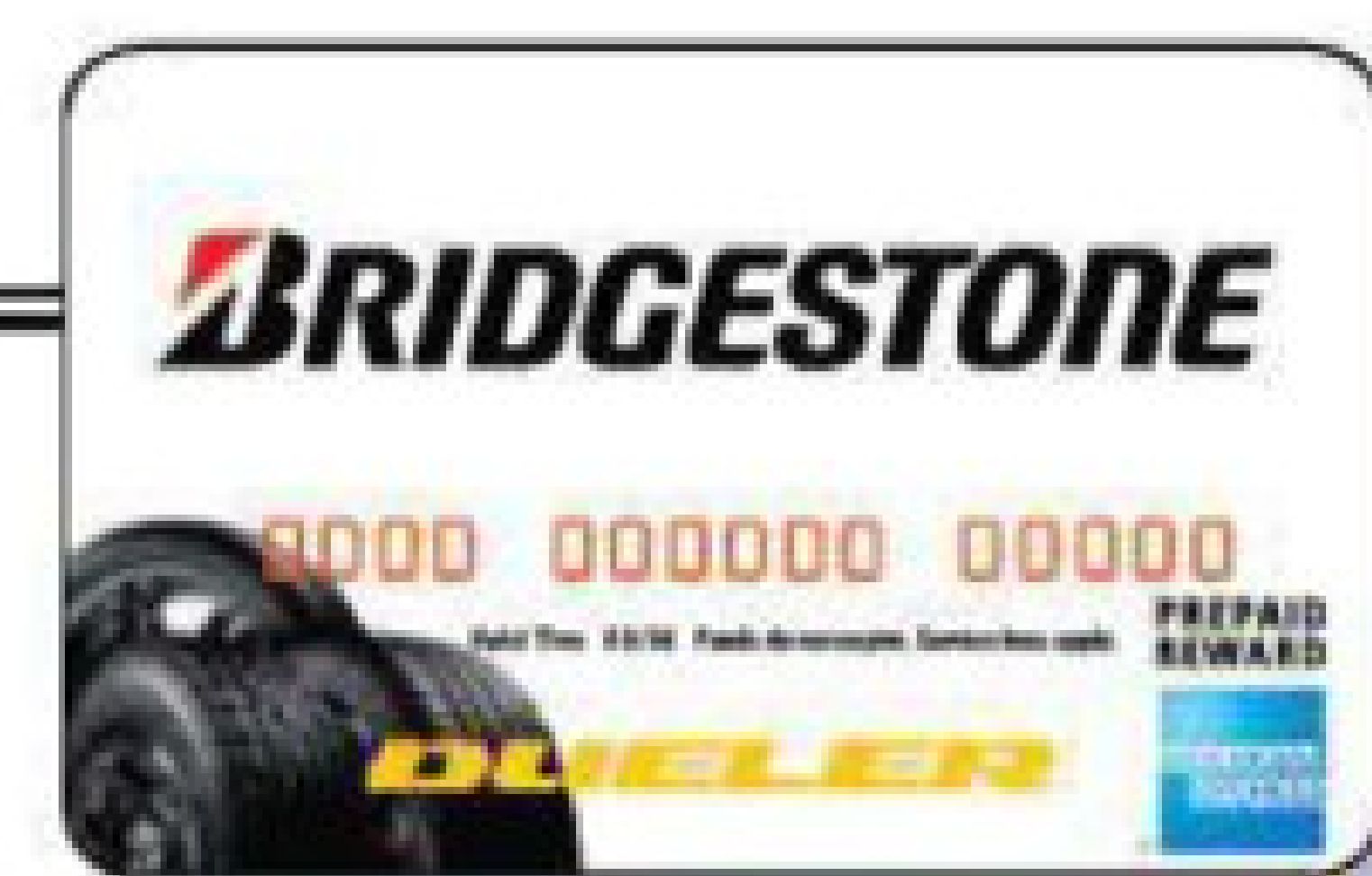
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